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Radial Labyrinth Packing.

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Introductory.—In a previous issue (Vol. XXXIX, March, 1927) of the Transactions, the writer described two graphical methods for determining the number of throttlings, and the fall of pressure through a labyrinth gland or dummy in which the constrictions were arranged axially. With this arrangement the cross sectional area through which flow takes place is the same at each constriction and the leakage per unit area is constant: hence the graphical methods previously described depended upon the product of the pressure and the pressure drop at each constriction being constant. When the constrictions are arranged radially the methods previously described no longer apply since the rate of leakage per unit area is no longer constant for each constriction. In the case of an outward radial flow turbine of the Brush-Ljungström type, shown in fig. 1, it is necessary to reduce to a minimum the steam leakage between the rotating labyrinth discs, which are attached to the blade discs h and h_1, and the stationary discs marked f. Fig. 2 shows to a larger scale how the constrictions

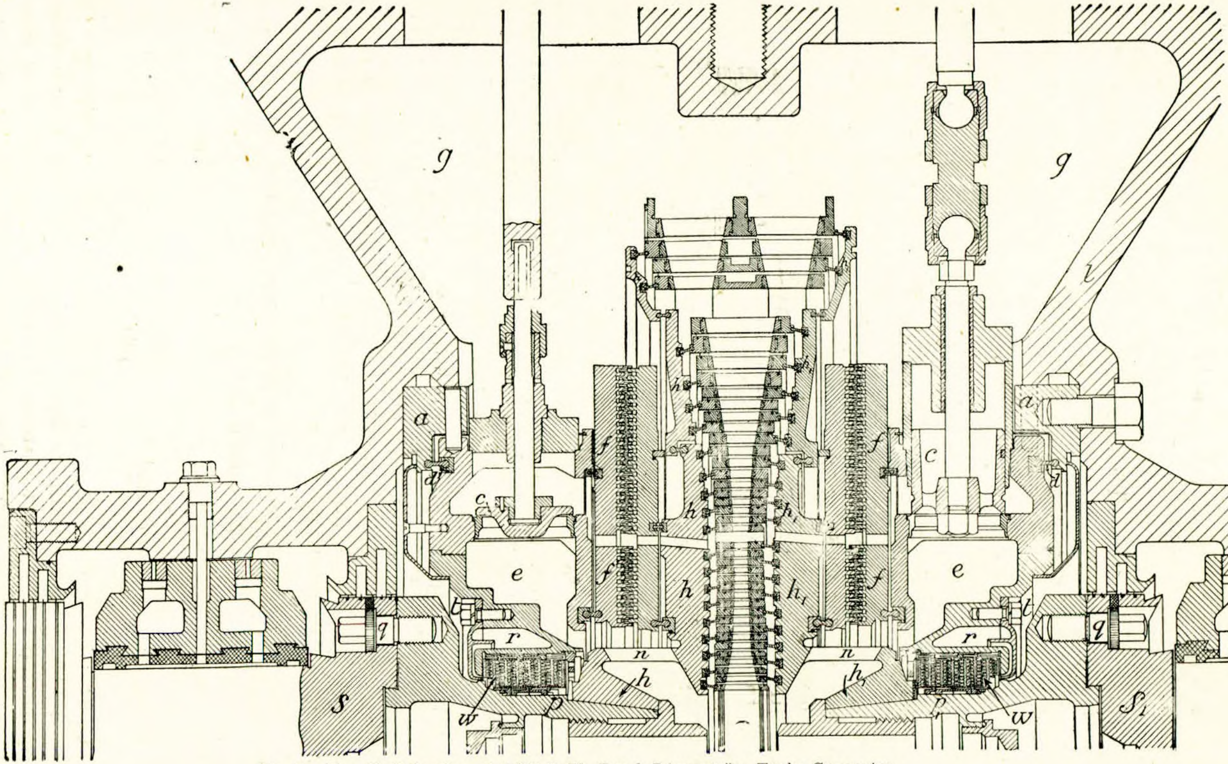

Fig. 1.—Top Half Section of 1,500 K.W. Brush Ljungström Turbo-Generator.

are arranged to give successive throttlings to the steam. Radial grooves A are turned in both rotating and stationary discs and a narrow ring B of nickel plate is caulked into the small groove of each projection. The clearances between the edges of the nickel rings and the sides of the grooves give a series of annuli of increasing area. In a 5,000 K.W. Brush-Ljungström turbine, the steam enters the labyrinth at a pressure of 200 lb./sq. in., and 245° F. of superheat and is throttled through 32 constrictions before reaching the overload byepass stage. The estimated leakage through this portion of the labyrinth is 670 lb. per hour or 1340 lb. for both sides. Part of this steam then enters the labyrinth arranged between the overload byepass and the exhaust space, where it passes through 72 constrictions: the leakage amounting to 250 lb. per hour or 500 lb. per hour for both sides. It is seen that 840 lb. per hour do useful work on the blades between the overload byepass stage and the exhaust, and 500 lb. per hour pass to the condenser without doing useful work. This loss is practically negligible, since it only amounts to approximately 1% of the total steam consumption per hour.

Determination of Pressure in Pockets.—The writer has shown on page 113 (Transactions, Vol. XXXIX, March, 1927) how to derive the following equation, which gives the relation between the initial pressure p_1 in lb. per sq. in., the pressure drop $p_1 - p_2$, W/A the leakage in lb. per sec. per sq. ft., and H_1 the initial total heat in B.Th.U.s per lb.

$$p_1 (p_1 - p_2) = \left(\frac{W}{A}\right)^2 \frac{1 \cdot 2464 \ (H_1 - 835)}{2g \cdot 144} \quad - - - (1).$$

This equation is applicable to the case of flow through a radial labyrinth since W and H_1 are constant and A can be obtained for each constriction.

Let d_1 = diameter at first constriction in ins.

,, c = clearance in ins.

,, x = radial pitch of constriction in ins.

Then $A_1 = \frac{\pi c d_1}{144}$ sq. ft. and $A_2 = \frac{\pi c d_2}{144} = \frac{\pi c (d_1 + 2x)}{144}$

The value of c for a Ljungström dummy is about 0·007 in. It is observed on referring to fig. 2 that each pair of constrictions is arranged at approximately the same radius. This is done so as to accommodate a large number of constrictions without

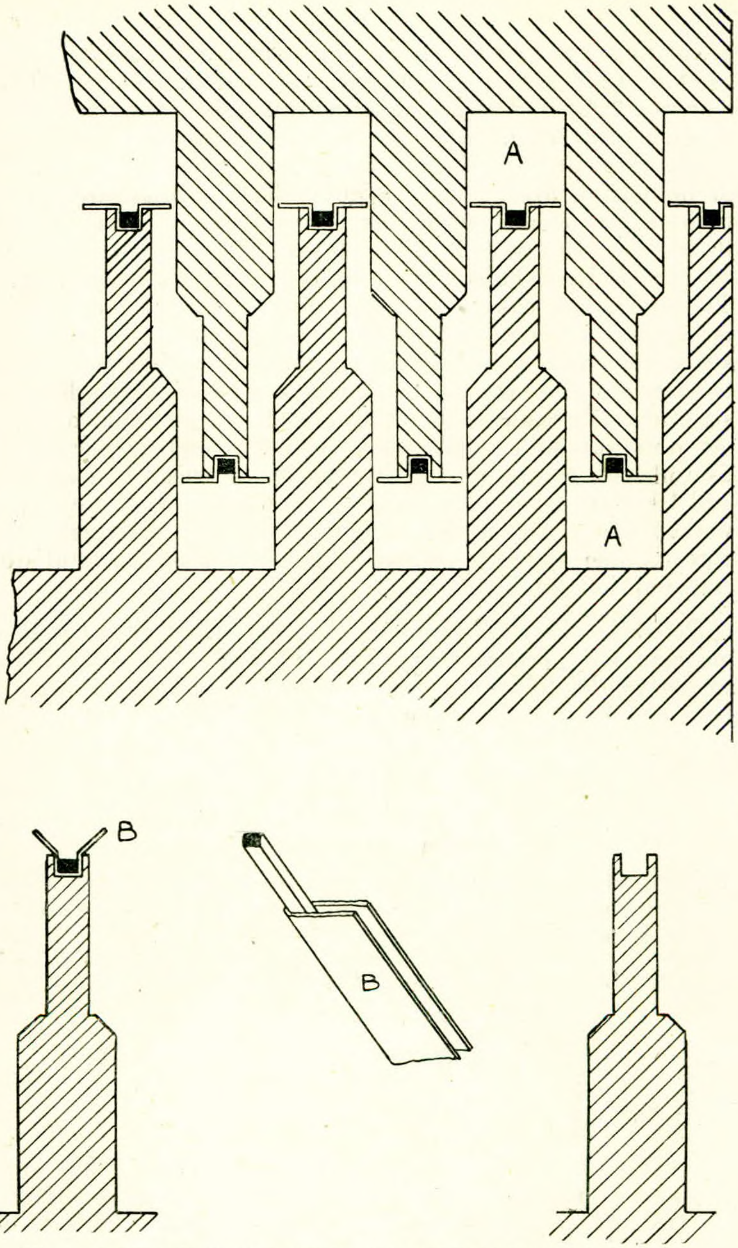

Fig. 2.—Details of Construction of Radial Labyrinth Brush Ljungström Turbine.

making the disc outside diameter unduly large. Hence for a Ljungström turbine, $d_2 = d_1$, $d_3 = d_4 = d_1 + 2x$, etc.

Equation (1) may be written, $p_1 (p_1 - p_2) = \frac{K}{d_1^2}$ - - - - (2).

where $K = \frac{1 \cdot 2464 (H_1 - 835) W^2 144 +}{2g\pi^2c^2}$

$$\frac{0 \cdot 2823 (H_1 - 835) W^2}{c^2} = \text{a const.} - (3).$$

For the determination of K when given the values of H, W, and c, the writer has developed the alignment chart shown in fig. 3. To use this chart draw a straight line through the value of H and the value of W to intersect the reference line at the point A. From A draw a straight line through the value of c and read off the value of K at the point of intersection. It should be noted that the scales are logarithmic and on the original chart from which the block for fig. 3 was made, all the scales were constructed from the B and C scales of a 10 inch slide-rule.

For the second constriction,

$$p_2 (p_2 - p_3) = \frac{K}{d^2_2} \text{ and for N throttlings}$$

$$p_N (p_N - p_{N+1}) = \frac{K}{d^2_N}$$

If the initial condition of the steam (pressure and degrees of superheat), leakage in lb. per sec., and clearance in ins. are given, H is obtained from the steam tables and the value of the constant K calculated from (3) or obtained as previously explained from the alignment chart, Fig. 3. AB (Fig. 4) is drawn to the largest possible scale equal to p_1, and AC perpendicular to it to the same scale equal to $\sqrt{K}/d_1$. DA is made to any convenient scale equal to d_1 and the rectangle DECA is completed. DF, DG, etc., are measured off to the same scale equal to d_1, d_2, etc., respectively. E is joined to F, G, etc. Then $HC = \sqrt{K}/d_2$, $LC = \sqrt{K}/d_3$, etc. Since FDE and ECH are similar triangles,

$$\frac{FD}{CE} = \frac{DE}{HC}$$

$$BC = \frac{CE.DE}{FD} = \frac{AD.AC}{FD} = \frac{d_1\sqrt{K}}{d_1} \cdot \frac{1}{d_2} = \frac{\sqrt{K}}{d_2}$$

With centre M on CE produced the arc of a circle is drawn

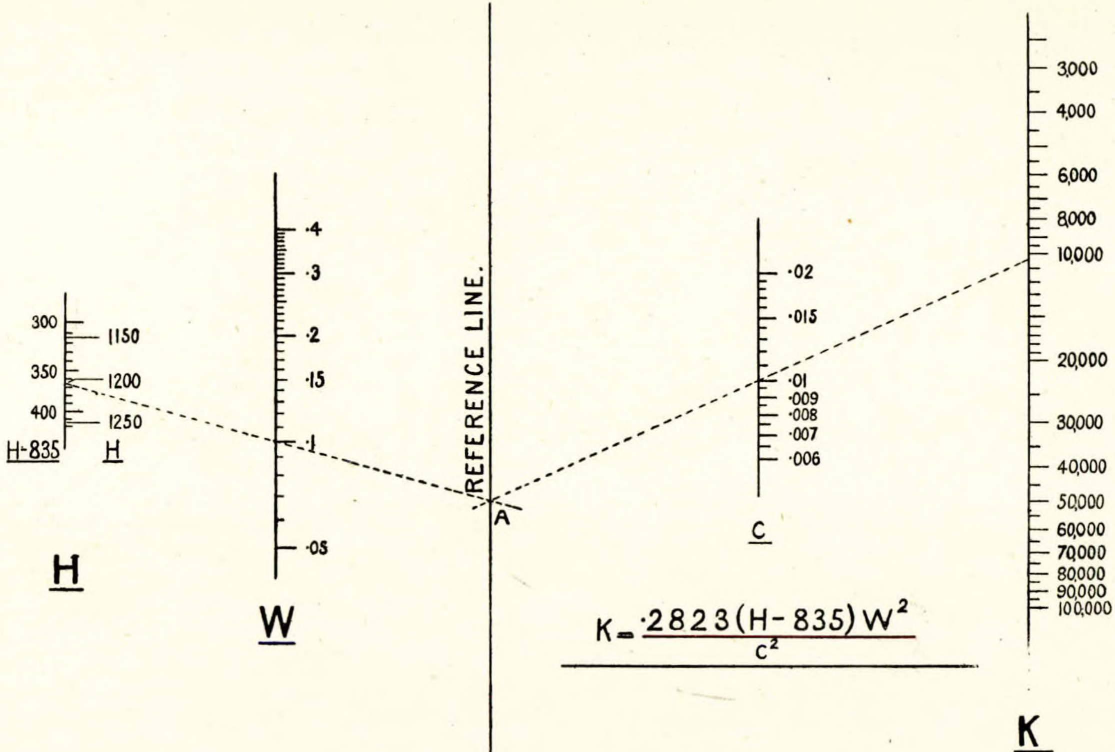

Fig. 3.—Alignment Chart for Determination of K.

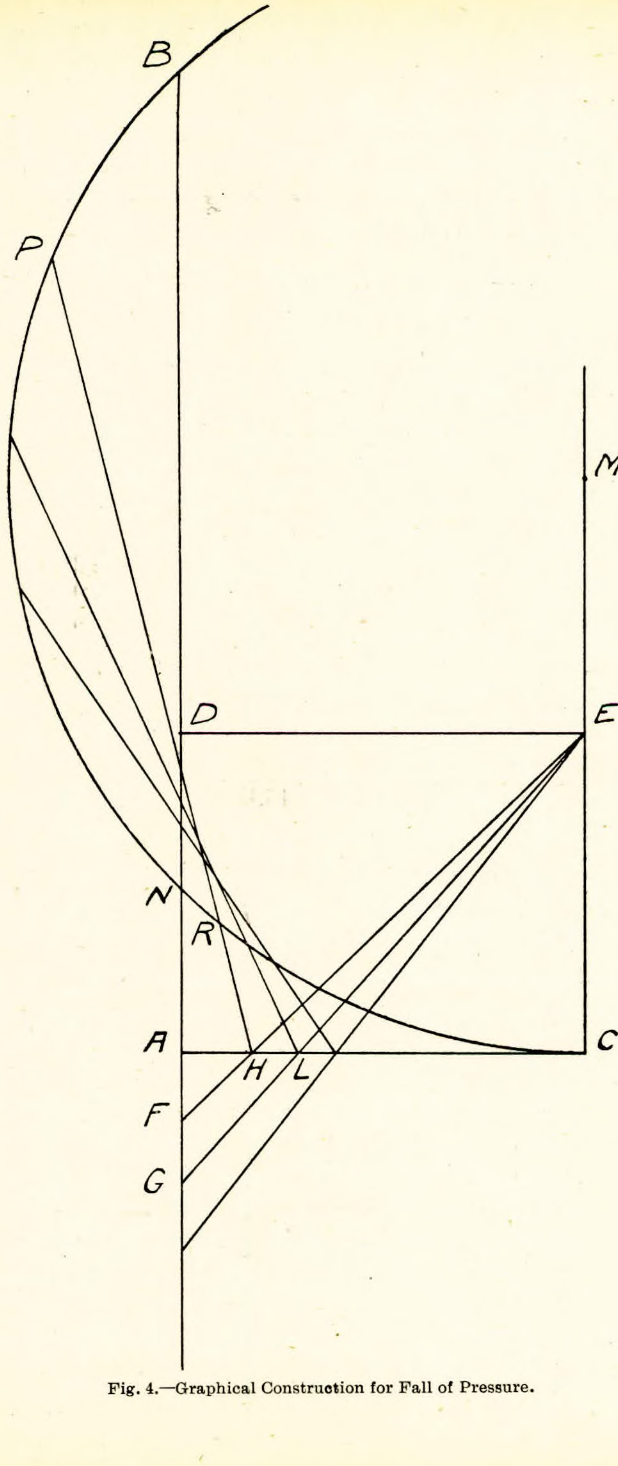

Fig. 4.—Graphical Construction for Fall of Pressure.

passing through the points B and C. Then since AB is a secant, AC a tangent and N is the point of intersection of the circle with AB—

$$AB.AN = AC \qquad \text{(Euclid 111, 37)}.$$

$$\therefore AN = \frac{AC^2}{AB} = \frac{K}{d_1{}^2 p_1} = p_1 - p_2$$

and BN $= p_2$.

With centre H and radius equal to BN the point P is marked and joined to H. Then HR $= p_2 - p_3$ and PR $= p_3$. This construction is then continued for the number of throttlings, i.e., until the final pressure p_{N+1} is reached.

Comparison with Other Methods.—All graphical methods for obtaining numerical values depend upon the accuracy of construction and upon the scale chosen. The writer using the above method and constructing the diagram to the largest possible on drawing paper of half imperial size has been able to obtain values for the pressures and the pressure drops to within 0·5°/₀. To compare this graphical method with other methods by calculation, the following example was taken.

Initial pressure, 150 lb. per sq. in. abs.

Initial temperature, 400° F.

Initial specific volume, 3·239 cubic ft. per lb.

Diameter at first constriction, 6 ins.

Diameter at last constriction, 13 ins.

Radial pitch, 0·25 in.

Number of throttlings, 15.

Clearance, 0·008 in.

Taking the final pressure as 30 lb. per sq. in. abs. and using Martin's† formula which has been rewritten in terms of the symbols used in this paper, viz. :—

$$W = \frac{c}{0 \cdot 674} \sqrt{\frac{d_1 \, d_N \, (p^2_1 - p^2_{N+1})}{\left(N + \log_e \frac{d_1 \, p_1}{d_N \, p_{N+1}}\right) p_1 \, v_1}} \text{ lb. per sec.} \quad \text{- - - - - - - - (4).}$$

Then W = 0·1756 lb. per sec. or 632·9 lb. per hr. The above formula has been used for calculating the rate of leakage as it appears to be the most popular formula with turbine designers in this country.

† "Steam Leakage in Radial Dummies." Engineering, Jan. 3rd, 1919.

Using the formula proved in the Appendix, viz.:—

$$W = \sqrt{\frac{g\,(P^2_1 - P^2_{N+1})\,A_1\,A_N}{P_1V_1N}}\ \text{lb. per sec.} \quad - - - - (5).$$

and substituting

$$0\cdot1756 = \sqrt{\frac{32\cdot2\,(150^2 - p^2_{N+1})\,\pi^2 \times 0\cdot008^2 \times 6 \times d_N}{144 \times 150 \times 3\cdot239 \times N.}}$$

from which

$$p^2_{N+1} = 150^2 - \frac{17{,}680N}{d_N} \quad - - - - (6).$$

Substituting in (6) for N the values 1, 2, 3, etc., and for d_N the corresponding values 6, 6·5, 7, etc., the pocket pressures are determined throughout the labyrinth. These pressures, together with the pressure drops at each constriction, are tabulated in the columns marked A and E of Table I.

Using the writer's graphical method the pressures and pressure drops obtained are given in columns B and F.

The most exact theoretical method for the determination of the pocket pressures is by the continuous application of the St. Venant and Wantzel§ formula—

$$W = A\sqrt{2g.\frac{n}{n-1}\cdot\frac{P_1}{V_1}\left\{\left(\frac{P_2}{P_1}\right)^{\frac{2}{n}} - \left(\frac{P_2}{P_1}\right)^{\frac{n+1}{n}}\right\}} \quad - - - - (7).$$

in which n is equal to 1·3 for steam which is either superheated or supersaturated. If r_1 be written for $\frac{P_2}{P_1}$, the pressure ratio for the first constriction.

Then $W = A_1\sqrt{\frac{2 \times 32\cdot2 \times 1\cdot3}{0\cdot3}\cdot\frac{P_1}{V_1}\left\{r_1^{\frac{20}{13}} - r_1^{\frac{23}{13}}\right\}}$ for the 1st constriction, and for the 2nd

$$W = A_2\sqrt{\frac{2 \times 32\cdot2 \times 1\cdot3}{0\cdot3}\cdot\frac{P_2}{V_2}\left\{r_2^{\frac{20}{13}} - r_2^{\frac{23}{13}}\right\}}\ \text{etc.}$$

The values of r_1, r_2, etc., could be obtained by Newton's method for solving equations, which would involve a large amount of tedious arithmetic. By evaluating the quantity in

§ "Mémoire et expériences sur l'ecoulement de l'air, déterminé par les différences de pressions considérables". de St. Venant and Wantzel. Journal de l'Ecole polytechnique, XVI. 1839.

the curly brackets for all values of r from unity to 0·5457 (the critical pressure ratio) and plotting a curve connecting this quantity and r, it is possible to determine the value of r for each constriction when $\frac{0 \cdot 3}{2 \times 32 \cdot 2 \times 1 \cdot 3} \frac{W^2}{A^2} \frac{V}{P}$ i.e., a value equal to the quantity in the curly brackets has been calculated for each constriction.

It should be noted that in making this step by step determination that use must also be made of the relation between P and V for the throttling curve, to eliminate the V's, viz.:

$$P_1V_1 = P_2V_2 = \text{etc., i.e., } \frac{V_1}{V_2} = r_1, \ \frac{V_2}{V_3} = r_2, \text{ etc.}$$

Using this method the pressures and pressure drop given in columns C and G respectively, Table 1, are obtained.

As a final comparison the Martin formula, (4) ante, has been adapted by the writer to determine the values of $\frac{p_1}{p_{N+1}}$ throughout the labyrinth. Putting this ratio equal to x and substituting the appropriate values for d_1, c, p_1 and v_1 then (4) can be written—

$$\frac{0 \cdot 7875}{d_N}\left(N + \log_e \frac{6x}{d_N}\right) = 1 - \frac{1}{x^2} \quad - - - - - \quad (8).$$

Writing $y_1 = 1 - \frac{1}{x^2}$ and giving x values from 1 to 5 (the final ratio) a curve is plotted with x as abscissæ. Putting $y_2 = \frac{0 \cdot 7875}{d_N}\left(N + \log_e \frac{6x}{d_N}\right)$ and then substituting in turn for N, 1, 2, 3, etc., and for d_N the corresponding values 6, 6·5, 7, etc., fifteen equations are formed. Plotting these with x as abscissæ fifteen points of intersection with the first curve are obtained, as shewn in Fig. 5. The values of x for these points of intersection are the values of the ratio $\frac{p_1}{p_{N+1}}$ throughout the expansion. From these ratios the pressures and pressure drops given in columns D and H are obtained. The values of the pressures by the four methods are plotted to a base of number of throttlings as shown in figure 6. It is observed that for the first few throttlings, when the pressure drops are small, there is very little divergence between the curves for the four methods. Towards the end the pressures as calculated from de St. Venant and Wantzel formula are much below those obtained by the other methods. Also curve C shows that the

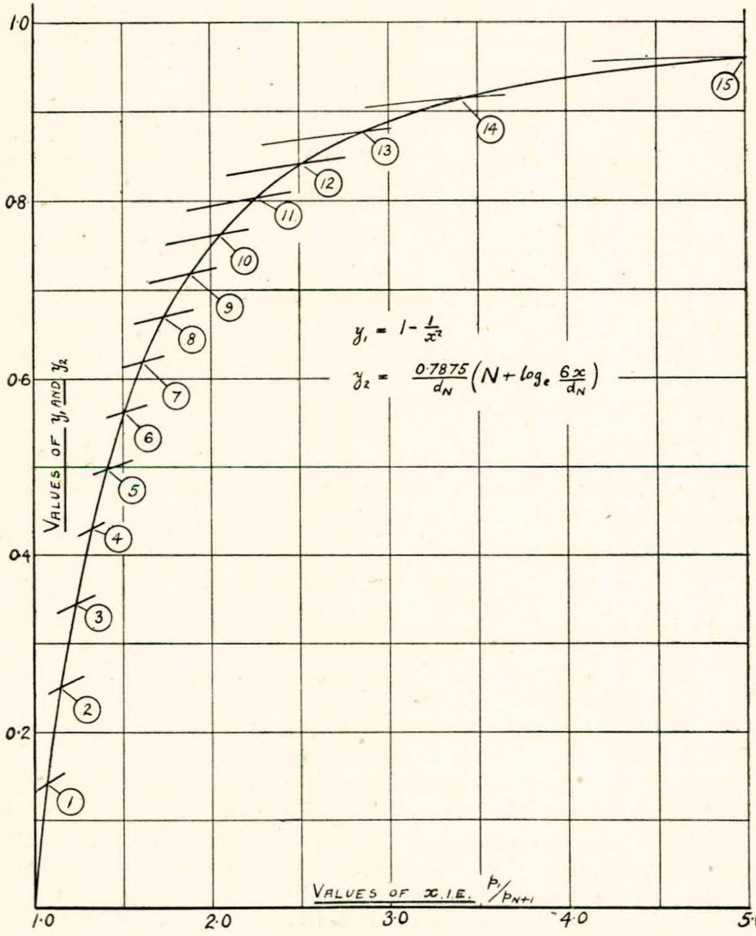

Fig. 5.—Graphical Determination of Ratio p^1/p_{N+1} using Martin's Formula.

critical is reached in the last constriction and consequently any reduction in the final pressure below 16·4 lb. per sq. in. will not affect the discharge. This is discussed in greater detail in Appendix No. 2.

TABLE 1.—*Pressure in Pockets and Pressure Drops for Radial Labyrinth Packing.*

Initial Pressure 150 lb. per sq. in absolute.

N	Pressure lb. per sq. in.				Pressure drop lb. per sq. in.			
	A	B	C	D	E	F	G	H
1	139·8	140·2	139·3	139·2	10·2	9·8	10·7	10·8
2	130·6	131·3	129·6	128·9	9·2	8·9	9·7	9·4
3	122·2	123·1	120·5	121·5	8·4	8·2	9·1	8·3
4	114·4	115·4	112·0	113·7	7·8	7·7	8·5	7·8
5	107·0	108·3	104·0	106·4	7·4	7·1	8·0	7·3
6	100·1	101·5	96·2	99·2	6·9	6·8	7·8	7·2
7	93·5	95·1	88·8	92·3	6·6	6·4	7·4	6·9
8	87·24	88·9	81·5	86·1	6·26	6·2	7·3	6·2
9	81·18	82·9	74·2	80·0	6·06	6·0	7·3	6·1
10	75·23	77·2	66·9	73·2	5·95	5·7	7·3	5·8
11	69·42	71·5	59·4	67	5·81	5·7	7·5	5·2
12	63·96	65·9	51·4	60	5·46	5·6	8·0	7·0
13	57·96	60·4	41·5	53	6·0	5·5	9.9	7·0
14	51·96	54·8	30·1	45·3	6·0	5·6	11·4	7·7
15	45·82	49·0	16·4	30	6·14	5·8	13·7	15·3

If the steam finally leaving the labyrinth is to discharge into a space in which the pressure is 30 lb. per sq. in. then according to the St. Venant and Wantzel theory—which assumes adiabatic expansion at each constriction—fourteen throttlings would suffice. When the pressure drops are small the graphical method should be used to determine the fall of pressure, and the formula proved in Appendix No. 1 used to calculate the number of throttlings required. Martin's formula is the most reliable formula for determining the leakage or the number of throttlings, whether the pressure drops are small or large, but its application to the determination of the fall of pressure involves too many subsidiary calculations. It should be borne in mind that the results set forth in this paper are theoretical and for practical application a suitable coefficient of discharge must be used. Dr. G. Stoney, F.R.S., according to Martin,* states that a suitable value to use would be between 0·65 and 0·7. Belluzzo† gives a value 0·95 for the coefficient of contraction for a radial labyrinth and suggests this should be multiplied by 0·95, which is a coefficient allowing for the effect of rotation on

*"Steam Leakage in Radial Dummies" Engineering. 3-1-1919.

†"Steam Turbines" Belluzzo. Translated by Eng.-Capt. Bremner, R.N.

the quantity flowing. This gives a coefficient of discharge 0·902, which is much higher than Stoney's value given above.

At present an experimental labyrinth apparatus, of the writer's design is under construction, and it is hoped that data dealing with fall of pressure, rate of leakage, coefficient of dis-

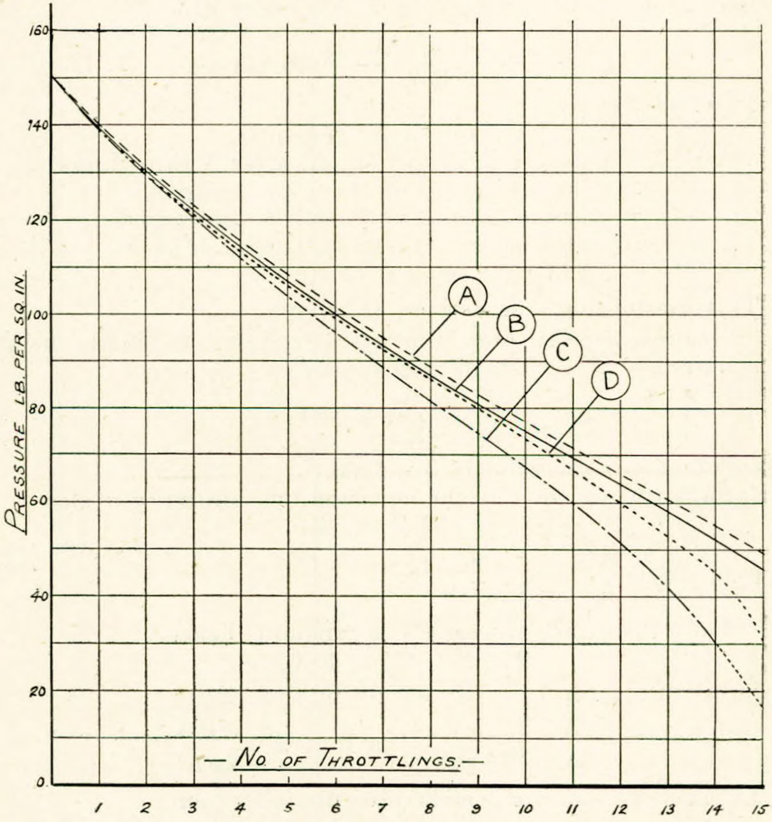

Fig. 6.—Curves showing Fall of Pressure in Radial Labyrinth.

charge, etc., for varying conditions will shortly be available for publication to supplement the theoretical work of this paper.

In conclusion, the writer wishes to thank The Brush Electrical Engineering Co., Ltd., Loughborough, for the loan of the block for Fig. 1, and for the data appertaining to the Brush Ljungström turbine given in the introductory paragraphs.

APPENDIX No. 1.

Determination of Number of Throttlings or Rate of Leakage. —When the pressure drop at each constriction is small, N, the number of throttlings, or W, the rate of leakage, may be calculated from the following formula stated by Stodola.*

$$W = \sqrt{\frac{g\,(P^2_1 - P^2_{N+1})\,A_1\,A_N}{NP_1V_1}} \text{ lb. per sec. - - - - - (i).}$$

In which,

P_1 = initial pressure in lb. per sq. ft.
P_{N+1} = pressure in lb. per sq. ft. after N throttlings.
A_1 = clearance area in sq ft. at first construction.
A_N = clearance area in sq. ft. at N^{th} construction.
V_1 = initial specific volume of steam in cu. ft. per lb.
g = 32·2 ft. per sec. per sec.

This formula may be derived as follows:—

Due to a pressure drop δP in a constriction, the kinetic energy acquired per lb. of steam is given by,

$$\frac{v^2}{2g} = V\delta P$$

in which v is the velocity of efflux.

Substituting for v in the equation for continuity of flow,

$$WV = vA$$

from which $\frac{W}{A} = \sqrt{\frac{2g\,\delta P}{V}}$ - - - - - - (ii).

For a throttling process PV is constant: hence,

$$PV = P_1V_1 = P_2V_2, \text{ etc.}$$

Substituting for V in (ii) we get by squaring,

$$\frac{W^2}{A^2} = \frac{2g\,P\,\delta P}{P_1V_1} \text{ or } P\,\delta P = \frac{W^2P_1V_1}{2g\,A^2}$$

Let r be the radius when the pressure is P: then

$$\frac{P\,\delta P}{\delta r} = \frac{W^2\,P_1\,V_1}{2g\,A^2\,\delta r} \text{ - - - - - - - (iii).}$$

But $\frac{A}{r} = \frac{A_1}{r_1} =$ - - - - - - $\frac{A_N}{r_N}$ hence (iii) may be written

$$\frac{P\,\delta P}{\delta r} = \frac{W^2P_1V_1\,r_1^2}{2g\,\delta r\,A^2_1\,r^2}$$

* "Angenäherte Theorie für kleine Druckunterschiede." Dampf und Gas-Turbinen. Stodola. 6th German Edition. 2 vols.

Since the pressure is decreasing as the steam flows radially outwards, dP/dr is negative: hence

$$- P\frac{dP}{dr} = \frac{W^2 P_1 V_1 r_1^2}{2g\,\delta r\, A_1^2 r^2}$$

Integrating between P_1 and P_{N+1} and r_1 and r_N

$$\int_{P_1}^{P_{N+1}} - PdP = \frac{W^2 P_1 V_1 r_1^2}{2g\, A^2_1\, \delta r}\int_{r_1}^{r_N}\frac{dr}{r^2} \text{ - - - - - - (iv).}$$

The method of continuous integration is used whereas the expansion through a labyrinth is discontinuous since it takes place in N steps as shown in Fig. (7). When the pressure drop is small for each constriction the above method is a sufficiently close approximation and there is no need to make a correction for discontinuity.

(iv) becomes, $\frac{P^2_1 - P^2_{N+1}}{2} = \frac{W^2 P_1 V_1 r^2_1}{2gA^2_1 \delta r}(1/r_1 - 1/r_N)$

$$= \frac{W^2 P_1 V_1 r_1}{2gA^2_1 r_N}\left(\frac{r_N - r_1}{\delta r}\right)$$

But $\frac{r_{N+1} - r_1}{\delta r} = N$, the number of throttlings: therefore

$$\frac{P^2_1 - P^2_{N+1}}{2} = \frac{W^2 P_1 V_1 r_1 N}{2gA^2_1 r_N} \quad \text{Also, } \frac{r_1}{r_N} = \frac{A_1}{A_N}$$

$$\frac{P^2_1 - P^2_{N+1}}{2} = \frac{W^2 P_1 V_1 N}{2gA_1 A_N}$$

Hence, $W = \sqrt{\frac{g\,(P^2_1 - P^2_{N+1})\,A_1 A_N}{P_1 V_1 N}}$ lb./sec., as quoted in (i).

If c is the clearance in inches, p_1 and p_{N+1} pressure in lb. per sq. in., d_1 diameter at first constriction in inches and x the radial pitch in inches:—

$$W = \cdot 8431c\sqrt{\frac{(p^2_1 - p^2_{N+1})d_1\{d_1 + 2(N-1)x\}}{p_1 V_1 N}} \text{ lb./sec., - - (v).}$$

To obtain the actual rate of discharge, W must be multiplied by a suitable coefficient of discharge as previously mentioned.

[These books have since been translated by Dr. Loewenstein, and copies are available in the Institute Library.—J.A.]

APPENDIX No. 2.

Modification to Formula when the Pressure Drop for the Last Constriction is Equal to or Greater than the Critical Pressure Drop.—The amount of leakage through a labyrinth gland will depend upon the ratio of the final pressure, P_{N+1}, to the pressure, P_n, in the last pocket. If $\frac{P_{N+1}}{P_N}$ is equal to, or less than

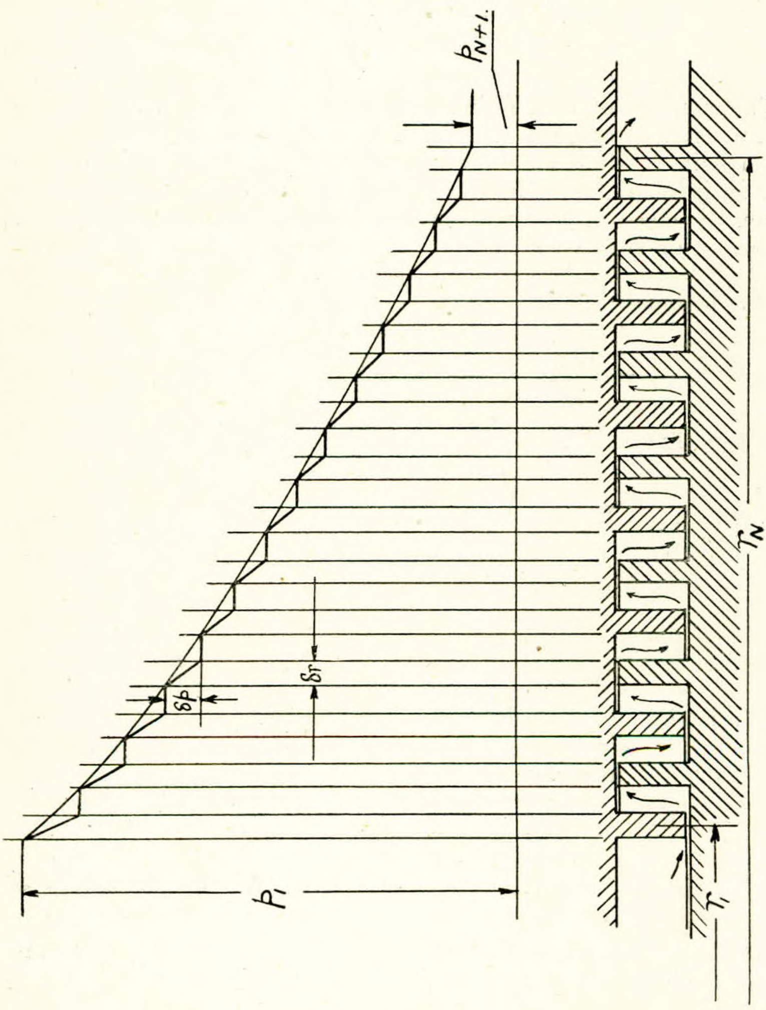

Fig. 7.—Pressure Drop in Radial Labyrinth.

0·546 the critical velocity is reached in the last constriction, and the discharge will be a maximum. Its value can be calculated from the following formula—

$$W = 3 \cdot 786\, A_N \sqrt{\frac{P_N}{V_N}} \text{ lb. per sec. - - - - (i).}$$

if A_N, P_N and V_N are known. The value 0·546 for the critical ratio has been used above since the steam remains dry through the successive throttlings, although the pressure is falling.

To derive a formula for determining the rate of leakage, the final pressure, and the pressure in the last pocket when the above condition holds it is necessary to equate the R.H side of (i) to the corresponding side of the equation (proved in the Appendix), replacing N by $N-1$, A_N by A_{N-1} and P_{N+1} by P_N, viz.:—

$$W = \sqrt{\frac{g\,(P^2_1 - P^2_N)\, A_1\, A_{N-1}}{P\, V_1\, (N-1)}} \text{ lb. per sec. - - - - (ii).}$$

Equating (i) and (ii) and squaring—

$$\frac{3 \cdot 786^2\, A^2_N\, P_N}{V_N} = \frac{g\,(P^2_1 - P^2_N)\, A_1 A_{N-1}}{P_1 V_1\,(N-1)} \text{ - - - - - (iia).}$$

But as previously shown for a throttling curve—

$$P_1 V_1 = P_2 V_2 \text{ - - - - - - - - } = P_N V_N.$$

Hence substituting $P_N V_N$ for $P_1 V_1$ in (iia) and solving for P^2_N

$$P^2_N = \frac{2 \cdot 247\, P^2_1 A_1\, A_{N-1}}{(N-1)\, A^2_N + 2 \cdot 247\, A_1\, A_{N-1}} \text{ - - - - (iii).}$$

(i) may be written—

$$W = 3 \cdot 768\, A_N \sqrt{\frac{P^2_N}{P_1 V_1}} \text{ - - - - - (iiia).}$$

Substituting the value of P^2_N from (iii) in (iiia).

$$W = 3 \cdot 768 \sqrt{\frac{2 \cdot 247\, A_1\, A_{N-1}\, A^2_N}{(N-1)\, A^2_N + 2 \cdot 247\, A_1\, A_{N-1}} \left(\frac{P_1}{V_1}\right)} \text{ lb./sec. (iv).}$$

Note.—For an axial labyrinth this simplifies to

$$W = 3 \cdot 768\, A \sqrt{\frac{2 \cdot 247}{(N-1) + 2 \cdot 247} \left(\frac{P_1}{V_1}\right)} \text{ lb./sec.}$$

since A is constant for each constriction.

If c is the clearance, d_1, diameter at first constriction, d_N, diameter at Nth constriction in inches, and p_1, the initial pressure in lb. per sq. in. absolute then (iv) can be written—

$$W = \frac{3\cdot768\sqrt{2\cdot247}\ \pi c}{12}\sqrt{\frac{d_1\,d_{N-1}\,d^2_N}{(N-1)d^2_N + 2\cdot247 d_1\,d_{N-1}}\left(\frac{p_1}{V_1}\right)}$$

$$\text{or } W = 1\cdot478\sqrt{\frac{1}{\frac{N-1}{d_1 d_{N-1}} + \frac{2\cdot247}{d^2_N}}\left(\frac{p_1}{V_1}\right)}\ \text{lb./sec-} \quad - \ - \ - \quad \text{(v)}.$$

If the radial pitch is constant and equal to x—

then $d_N = d_1 + 2(N-1)\,x$

and $d_{N-1} = d_1 + 2(N-2)\,x$

To illustrate the use of the preceding formula the data used in the example on page 4 have been taken.

Substituting these values in (v) the leakage is 0·1796 lb. per sec., and using this value for W in (i)—

$$\frac{p_N}{V_N} = 3\cdot284$$

$$\text{But } p_N V_N = p_1 V_1 = 150 \times 3\cdot239$$

$$p^2_N = 150 \times 3\cdot239 \times 3\cdot284$$

$$\therefore p_N = 40\cdot2 \text{ lb. per sq. in.}$$

Hence the final pressure p_{N+1} may be equal to or less than 40·2 × ·546, i.e., 21·9 lb. per sq. in for maximum discharge to take place through the labyrinth. If the steam from this gland were led to a stage in the turbine at which the pressure was less than 21·9 lb. per sq. in. then the discharge would be a maximum. Should the stage pressure due to a change of operating conditions exceed 21·9 lb. per sq. in. the leakage would be reduced to a value below 0·1796 lb. per sq. in.

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" The Present Trend of Marine Engine Building."

By E. R. HALL (Graduate),

Lloyd's Register Scholarship Holder, 1927-29.

The Shipbuilding Statistics compiled and published by Lloyd's Register of Shipping are acknowledged in statistical circles as being the most accurate and representative figures on the subject. When one remembers that 60% of the tonnage built during the past 20 years has been to Lloyd's classification it is not surprising that an organisation of this sort should be able to compile reliable figures.

An engineer is not concerned, however, so much with statistics as such; he is more interested in a general indication of progress in any one particular direction. Unfortunately he is not able to find quite all that he wants in these figures.

With regard to a study of the relative use of reciprocating, turbine, and motor engines, it is certain that the best standard of comparison is on the basis of power. There may be a definite connection between the tonnage of a ship and the power of the engine put into it. This connecting link is sure to vary a little if not considerably, and the study of any question can only give a very rough idea of the real position if engine power is based on figures of tonnage.

Up to a few years ago when Lloyd's Register published its first table of engine building statistics, there was no choice in the matter, and all comparisons had to be made on tonnage. Now that we are supplied with particulars of the number, type and horse-power of engines under construction during each quarter, an engineer is able to handle definite figures and to say that of a certain total horse-power building, a definite amount is, say, motor horse-power.

Here again care is necessary. It will not do to work with figures under the impression that they are particulars of engines produced. The tables given in Lloyd's Register Quarterly Reports are given as—" engines under construction during quarter ending . . ."—and these certainly cannot be production figures, since if any engine takes more than three months to build, it may reasonably appear in more than one report. Thus we see that a time factor enters into the relationship between engines building and engines built.

For instance, assuming that a reciprocating engine takes longer to build than a turbine of the same power, then the percentage of reciprocating engines building will be higher than the percentage of the total power built. It is reasonable to suppose that the building time for an engine is definitely related to its type, and that the relationship will be a constant.

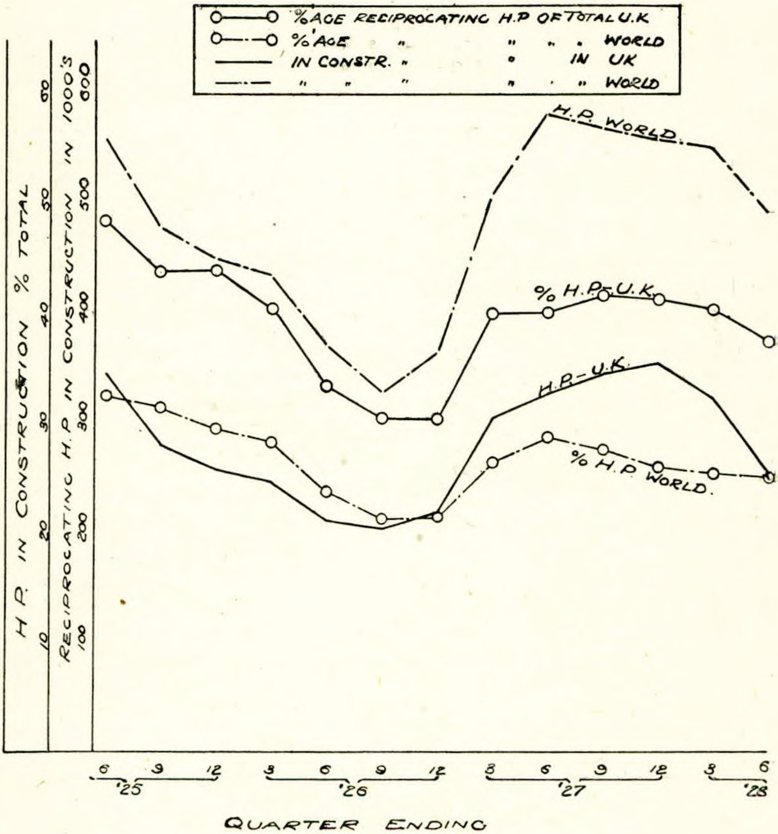

Fig. 1.

Then obviously the figures given by Lloyd's of engines under construction form a more reliable means of studying a question relating to marine engines than tonnage figures.

It may seem early yet to attempt to analyse these figures since only thirteen sets have been published, but an examination of these is at least interesting.

Fig. I shows a comparison between the steam reciprocating H.P. in construction in the World and the corresponding figures for the United Kingdom. It is seen that the curves are very similar, and that quite a large part of the World's total steam reciprocating engine building is in the United Kingdom.

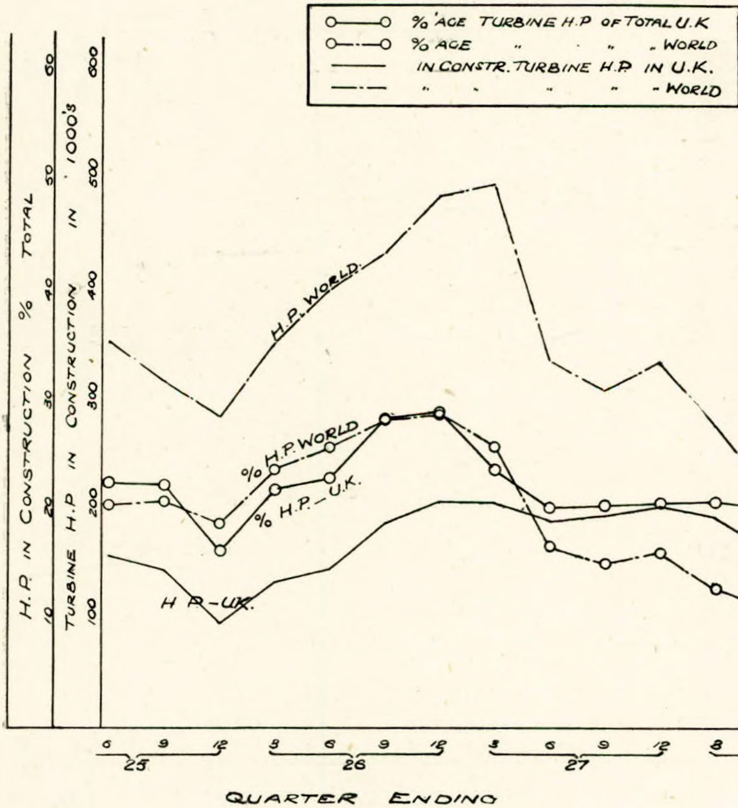

Fig. 2.

The percentage curve for the United Kingdom is above that for the World, thus clearly showing that the United Kingdom is building a much larger proportion of its total horse-power in steam reciprocating engines than the proportion for the World as a whole.

In Fig. II the turbine building percentage curve follows very closely the World curve up to the end of March, 1927, when the curves begin to diverge. Beyond this point the United Kingdom is producing a larger proportion of turbines than the World.

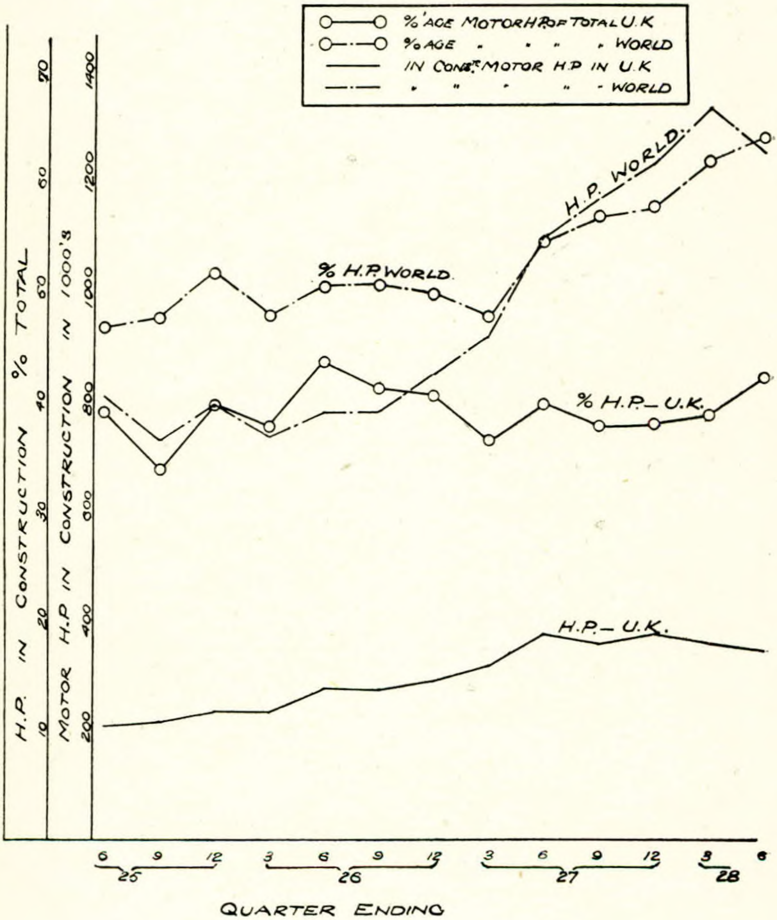

Fig. 3.

In Fig. III we have it plainly shown that the United Kingdom is not building motor engines in anything approaching the World tendency.

The sharp rise during 1927 certainly produces a small rise in the horse-power building in the United Kingdom, but it will be seen that where the World's motor percentage has increased by about 10% during that period, the United Kingdom percentage curve is practically steady. This, of course, indicates

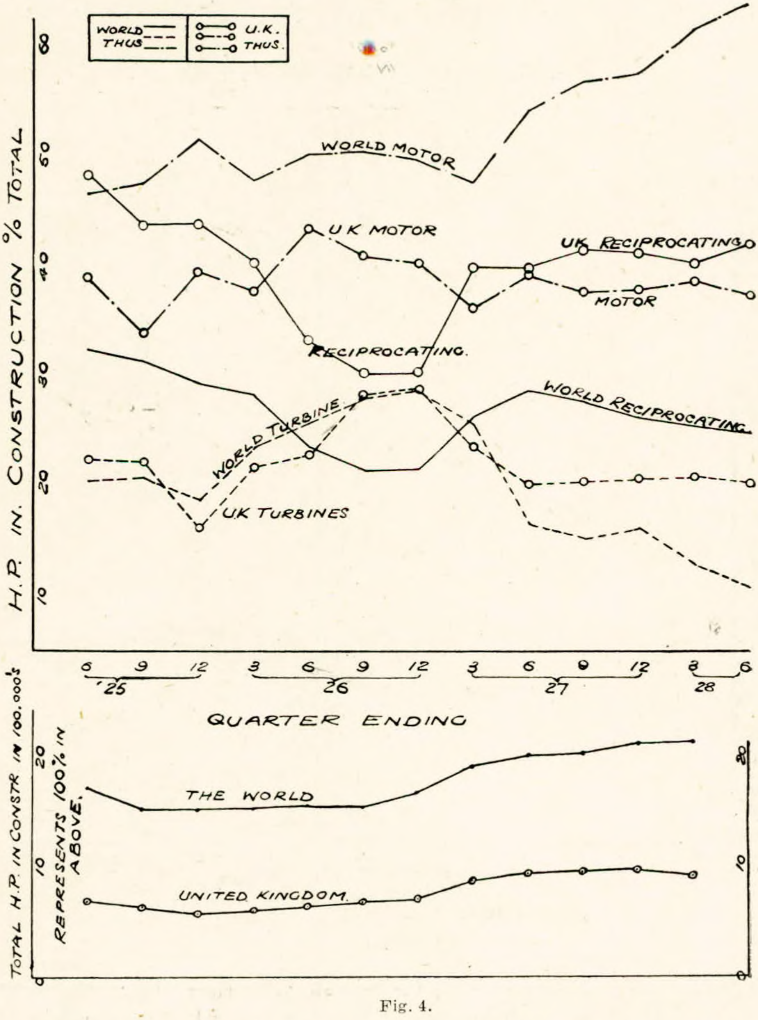

Fig. 4.

an increase in motor building in the World in excess of the increase of steam building, whereas in the United Kingdom the increase is more general.

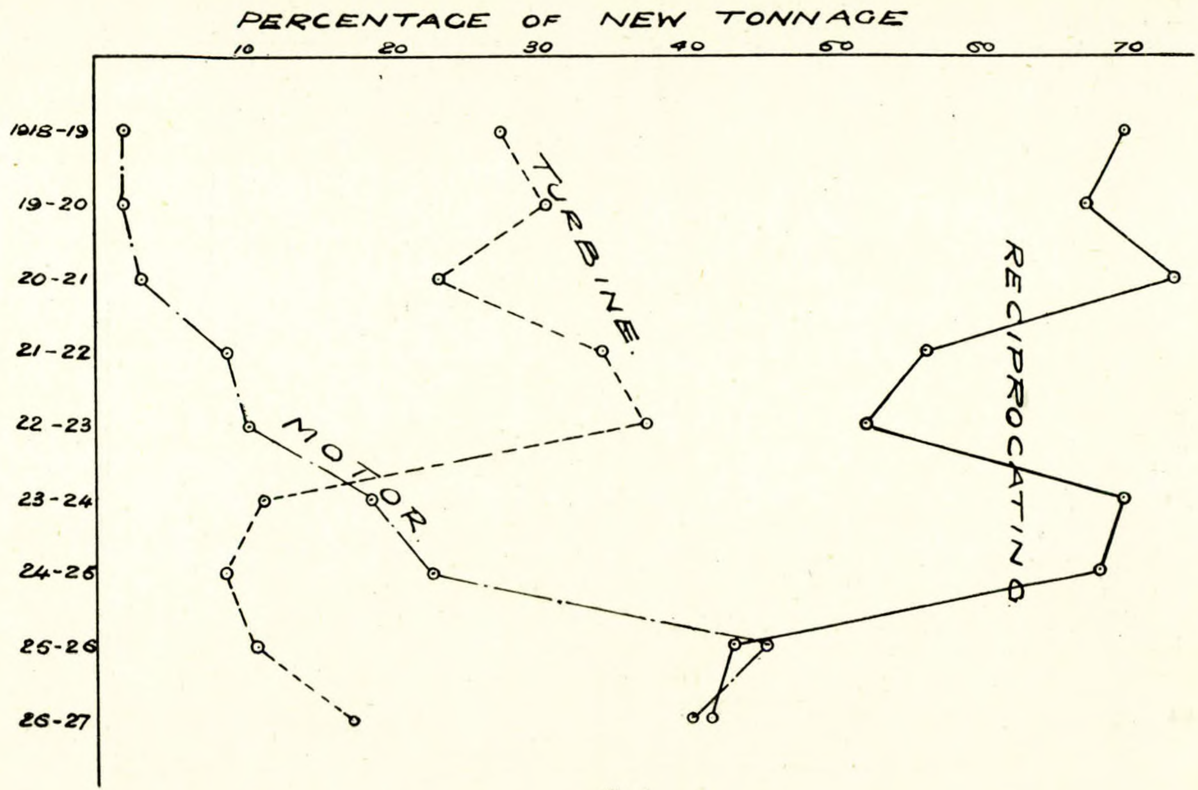
PERCENTAGE OF NEW TONNAGE
10
20
30
40
50
60
70
1918-19
19-20
20-21
21-22
22-23
23-24
24-25
25-26
26-27
TURBINE.
RECIPROCATING.
MOTOR.

Fig. 5.

It seems noteworthy that in Fig. IV the steam reciprocating percentage for the United Kingdom showed a decrease for 1926. There was a corresponding increase in turbine percentage, whilst the motor percentage remained fairly steady. This seems to indicate a distinct rivalry between turbine and reciprocating machinery for popularity apart from any mutual competition against the motor.

Fig. V seems to show this point even more clearly, although the figures are taken on the unsatisfactory basis of tonnage.

Any sharp rise in reciprocating seems to be accompanied by a corresponding drop in the turbine popularity and vice versa; meanwhile the motor goes on steadily gaining ground until it leaps into prominence in the last four years at the expense of both the steam engines.

It would appear that although the geared turbine is spoken of quite frequently as the great rival of the motor, the decrease in the turbine's popularity has been even greater in proportion than the decrease in reciprocating during recent motor development.

What the future of the marine engine will be it is difficult to forecast. It certainly seems that motor users will eventually reach a maximum and that the remaining engine building will be divided between reciprocating and turbine in an ever fluctuating ratio, the two last-named remaining in competition with one another and neither one dying out nor affecting the extent of motor building.

TABLE A.

TOTAL MARINE ENGINES UNDER CONSTRUCTION—THE WORLD.

(HORSE-POWER BASIS.)

		Reciprocating.		Turbine.		Motor.	
Quarter ending.	World's Total.	H.P. in 1000's.	% of Total.	H.P. in 1000's.	% of Totals.	H.P. in 1000's.	% of Total.
6/25	1721	560	32·6	353	20·5	808	46·9
9/25	1523	478	31·4	318	20·9	727	47·7
12/25	1523	450	29·5	284	18·7	789	51·8
3/26	1529	433	28·3	362	23·7	734	48·0
6/26	1553	371	23·9	400	25·8	782	50·3
9/26	1546	329	21·3	435	28·2	782	50·5
12/26	1696	365	21·5	487	28·7	844	49·8
3/27	1922	507	26·4	497	25·8	918	47·8
6/27	2021*	581	28·8	338*	16·7	1102	54·5
9/27	2042*	569	27·8	310*	15·2	1163	57·0
12/27	2135*	557	26·1	344*	16·1	1234	57·8
3/28	2161*	550	25·4	277*	12·8	1334	61·8
6/28	1959*	492	25·1	214*	10·9	1253	64·0

* Figures for Turbine Engines building in Germany not available.

Figures approximated from Lloyd's Reg. Reports.

TABLE B.

MARINE ENGINES UNDER CONSTRUCTION IN U.K.

(HORSE-POWER BASIS.)

Quarter ending.	Total in 1000's.	Reciprocating. H.P. in 1000's.	Reciprocating. % Total.	Turbine. H.P. in 1000's.	Turbine. % Total.	Motor. H.P. in 1000's.	Motor. % Total.
6/25	709	344	48·5	158	22·3	207	29 2
9/25	642	282	43·9	143	22 2	217	33·9
12/25	588	259	44 0	95	16 2	234	39·8
3/26	613	248	40 4	133	21·8	232	37 8
6/26	636	212	33·4	146	23·0	278	43 6
9/26	668	204	30·5	189	28·3	275	41·2
12/26	721	220	30·5	209	29 0	292	40.5
3/27	882	353	40·0	209	23·7	320	36·3
6/27	940	377	40·1	190	20·2	373	39·7
9/27	945	394	41·7	191	20·5	357	37·8
12/27	982	406	41·3	203	20·7	373	38·0
3/28	919	372	40·4	192	20·9	355	38·7
6/28	813	306	37·6	164	20·2	343	42·2

Figures approximated from Lloyd's Reg. Reports.

TABLE C.

NEW TONNAGE BUILT TO LLOYD'S CLASSIFICATION.

Over Period.	World's Total in 1,000's.	Reciprocating. Gross Tons in 1000's	Reciprocating. % Total.	Turbine. Gross Tons in 1000's.	Turbine. % Total.	Motor. Gross Tons in 1000's.	Motor. % Total.	Fuel. Coal % Total.	Fuel. Oil % Total.
1918/1919	3761	2634	70·1	1051	27·9	76	2·0	66·2	33·8
19/20	4187	2821	67·4	1286	30·7	80	1·9	50·4	49·6
20/21	3229	2373	73·5	755	23·4	102	3·1	39·0	61·0
21/22	2518	1421	56·5	870	34·5	227	9·0	35·5	64·5
22/23	1611	842	52·3	603	37·4	165	10·3	41·1	58·9
23/24	0875	611	69·8	99	11·3	164	18.9	53·5	46·5
24/25	1311	895	68·2	114	8·7	302	23·1	51·2	48·8
25/26	1325	576	43·4	146	11·0	602	45·4	31·6	68·4
26/27	967	405	41·9	169	17·5	393	40·6	30·8	69·2

Figures 1918-26 taken from League of Nations documentation, "Shipbuilding," Geneva, 1927.

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Royal Sanitary Institute Congress.

Report of proceedings at the Royal Sanitary Institute Congress at Plymouth, July 14th to 21st, when about 900 delegates attended, including representatives from Government Departments—Home and Colonial—Foreign Governments, Municipal Authorities in England, Scotland, Ireland and Wales, and over a dozen Institutions embracing land and marine work.

On the 14th the delegates were received in St. Andrew's Abbey Hall, where they obtained copies of the Papers to be read and booked their arrangements for the week.

On Sunday morning the fine old St. Andrew's Church was occupied by a large congregation, and the Bishop of Plymouth gave a warm welcome to the delegates, expressing the hope that the Congress would be a successful event in the interest of all in the widest sense. In his sermon he pointed out that sanitary science deserved help, sympathy, and admiration, because it is a positive effort to deal with some of the evils of the world. It is better to fight for the good than to rail at the ill. Railing at the ill is just the cheapest way in which we can satisfy, or try to satisfy, our own conscience, because it calls for no effort and involves no sacrifice. Railing at the ill just means dividing into hostile camps the very people who ought to be working together for the amelioration of the evils from which the world is suffering.

"Sanitary science teaches us to rally to the battle against the hordes of evil. How is this to be done? Our welcome guests know the real obstacles. Break down apathy, remove the dead weight of old custom, stir men to the desire for better things. We have to enlist the active sympathy of every man on the side of health and cleanliness, and it is a great part of the clear duty of the Christian Church to help to remove this apathy, to get rid of the patient endurance which masquerades as a virtue, but is the outcome of ignorance and helplessness. There are many things ignorant people have regarded as inevitable which are not inevitable if we gird our loins to meet them."

"Unless you can turn the forces of Nature to the side of good, civilization will probably destroy itself, not by its own ignorance, but by its own knowledge. It is one of the supreme problems of our day, how we may call into exercise all those great forces that God has given to modern science, and how we may ensure that man will use them in the cause of good, and not for purposes of selfish aggrandisement and destruction.

The outcome of science must be to make life richer and nobler, to weigh the balance on the side of making life happier and cleaner."

"When you have cleared our cities of defilement, and when our rivers flow clean and pure, and when our refuse heaps are clothed with flowers, the countryside purged of the abominations of to-day, when all the dreams of sanitary reformers have been achieved, what will it be worth unless you can give men restored fellowship with God? Pride, hatred, lust, greed will make a hell of any paradise. You can build, but of what use is it to lodge your mind in a palace if you have a slum in your heart? There is a task of spiritual sanitation which is the special work of the Christian Church in order that clean bodies shall be inhabited by clean souls."

Some of the delegates attended the George Street Baptist Church, and the Rev. T. W. Riddle based his discourse on an intelligent view of the conditions of life and the desirability of upholding plans for the amelioration of sufferers whose positions can only be improved by the inter-position of sympathetic workers.

The Presbyterian Church minister, the Rev. J. Howell, at the evening service, also expressed the hope that the Congress would help to throw light on many of the ills of life and show how to banish these and bring about a higher and brighter aspect. The Congress would be beneficial to Plymouth and its results of value.

On Monday the proceedings were as follows:—

The opening reception ceremony was held by the Lord Mayor (Councillor H. J. Priest) at a luncheon in the Royal Hotel at one. The Lord Mayor proposed the "Royal Sanitary Institute," and indicated how greatly improved the conditions of the national health had become since the Institute was formed, and not only so but the work and operations the members carried on, was extended beyond the seas in regard to the improvements in the conditions of life, as the presence of delegates from abroad testified. Plymouth was somewhat out of the way from London, but the Conference would be beneficial to the town and the scenery around would be good for the visitors to look upon and they would carry pleasant memories away as one result of their visit.

The Chairman of the Congress Committee, Dr. C. Porter, in responding, noted that the Mayor was evidently at one with the Congress in the objects in view. The visit to Plymouth was to spread the knowledge wider and to advocate better habits to bring about healthier conditions to mind and body.

Mr. Ed. Willis proposed the Mayor and Town Council, and congratulated Plymouth on the efforts which had been successful in improving the town and those that were still in progress to further advance it, and give greater facilities for health and recreation.

Alderman H. M. Medland, Chairman Public Health Committee responded and expressed the view that Plymouth residents were well pleased with the improvements made and the succeeding generation would witness still better things. The visitors were invited to look around and see what had been done and what was proposed. Their water supply was pure and reliable at all times. He welcomed the delegates and hoped their visit would be pleasant and instructive.

At 2.45 the delegates assembled at the parade ground of the Drill Hall, when a group photo was taken, after which the Health Exhibition was opened in the Drill Hall by the Mayor, who remarked on the value of the exhibition to show the public the articles of up-to-date service for homes. The exhibits had been carefully examined and reviewed by a committee of experts, and medals were awarded to exhibitors accordingly.

The exhibits were interesting and embraced the latest improvements made in household appliances for hygiene and health. The exhibition was open to the public during the week. The exhibits included Infant and Invalid Foods, Household and Kitchen Appliances, Filters, Water Softeners, Refrigerators, Gas Stoves and Fittings, Electric Appliances, School and Office Furniture, Soaps and Disinfectants, Coal and no smoke, Sanitary Appliances.

The Presidents and Secretaries of the various sections, under which Papers were to be read, met at 4.15 to confer on the arrangements. The sections were: A, Preventive Medicine; B, Engineering and Architecture; C, Maternity and Child Welfare; D, Personal and Domestic Hygiene; E, Hygiene of Food: F, Hygiene in Industry; G, Veterinary Hygiene; H, Special Conferences: I, Sanitary Authorities; II, Port Sanitary Authorities; III, National Health Insurance Services; IV, Medical Officers of Health; V, Engineers and Surveyors; VI, Sanitary Inspectors; VII, Health Visitors. The meetings from 10 a.m. were held in the Municipal Buildings, Guildhall, St. Andrew's Abbey Hall, and the Stonehouse Town Hall. Afternoon visits were arranged to works, Hospitals and places of interest; these had to be booked well ahead at certain rates when char-a-bancs had to be provided.

The inaugural address of the President, Lord Astor, was delivered on Monday evening, in the Guildhall. He passed on a review of the different phases of health work which were of interest to those assembled together. Smoke pollution had not been adequately dealt with yet, in spite of all the protests made on the subject and the Acts passed. Oil poisoning of the waters and the pitiful results, the standard for pure milk, the work of the Municipal and Sanitary Authorities welfare work, improving town and district housing, opening up narrow streets, and devoting attention to Sabbath observance. True happiness and welfare were gained and retained not by excitements and rushes after so-called pleasure but by quiet and contentment. There had been great improvements during recent years in regard to all the points referred to, and many of the ailments which affected humanity had been banished and others greatly reduced, thus giving cause for rejoicing. Ultra violet rays and vitamen D combined had been of great service, especially to rickety children. This might be termed a nature's cure and a wonderful improvement had been made in regard to plagues, as small-pox and similar ills. The pollution of the air by smoke had been checked to some extent, but still there was room for lessening it. The suffering of the birds, and possibly also, fish, by the leakage of oil upon the waters, was painful and ought to be stopped. The quality of milk had been improved and a higher standard aimed at. The Factories and Works were given closer attention in respect to health and cleanliness, with accommodation for fresh air recreation. The health of the people should depend less on medicinal drugs and more upon sanitation and life-giving action, avoiding the evil and cleaving to the good, adding to the courtesies of living and helping to cure errors and mistakes.

The Right Hon. J. Ramsay MacDonald, M.P., proposing a vote of thanks to Lord Astor, said he had been associated with the work of sanitation for many years and had devoted both time and money to advance the good cause. The gist of the advice given in his wide views of what should be done to improve the conditions of life was that it was the duty of all. One reference by Lord Astor reminded one of the days of childhood, when castor oil was administered. The treatment administered in Italy to the rebel clan illustrates the value of the dose in drastic form.

The Bishop of Plymouth seconded the vote and expressed his strong sense of the debt of gratitude which Plymouth owed to Lord and Lady Astor. Dr. T. Clark, United States Public Health Service; Major P. F. Gow, Bengal Government; Councillor P. Given, Convener Health Committee, Edinburgh; also voiced their appreciation as representatives.

On Tuesday at 10 a.m. Sections A, E and F and Conferences VI and VII met, when papers were read and discussed. Section A. Preventive Medicine was the theme for consideration. The study of problems regarding tuberculosis, under the chairmanship of Dr. L. Rajchman, Medical Director, Secretary of the Health Committee, League of Nations. The study of problems regarding tuberculosis was emphasised and the importance of improving the service for discovering and reporting cases in order to reduce the limits of the disease. Other ailments, measles, small-pox, scarlet fever, etc., were also dealt with in Section A. In Section E, Chairman Jas. Y. Johnson, Prime Warden, Worshipful Company of Fishmongers, the food supply was dealt with, and reference was made to the days of Cæsar, when oysters were served at the palatial dinners in Rome, and now-a-days, large quantities are imported to Britain from Portugal, France, Holland and America. Hygiene in Industry, Section F, Chairman The Rt. Hon. J. Ramsay MacDonald, P.C., LL.D., M.P. "The Factory Worker and Industrial Hygiene" was introduced by Alderman Ben Turner, Chairman Public Health and Housing Committee, West Riding County Council, who gave his reminiscences and experiences in regard to the textile factories in Lancashire, Yorkshire and elsewhere, and the great improvements made for the well-being of the workers. Papers by C. F. Coombs, M.D., F.R.C.P., Bristol General Hospital, and L. P. Lockhart, M.D., M.R.C.S. —Messrs. Boots Pure Drug Co.—dealt with the industrial workers in factories and works under improving conditions.

At Conference VI—Chairman, E. Whone, Chairman Sanitary Inspectors' Association—"Contamination of Food Stuffs when *Exposed for sale," by G. E. Body, Senior Sanitary Inspector, Torquay; "Present Day Sanitary Practice," by A. W. Good, Sanitary Inspector, Plymouth; "The Ventilation of Geysers—Bristol's New Powers," by J. A. Robinson, Chief Sanitary Inspector, Bristol; "Description and Explanation of an Up-to-

* See page 428.

date Salvage Plant for Refuse Disposal," by H. Y. Stazicker, Superintendent, Public Health Dept., Crewe; and "Modern Steam Generators and Smoke Abatement," by J. Law, Smoke Inspector, Liverpool, were the papers considered and debated on Tuesday.

* The discussion on this subject has been helpful in emphasising to the Congress the desirability of the authorities and food suppliers being careful and circumspect. The cases of the policemen affected by similar illnesses seemed to indicate a contaminated food supply. The articles by Sir Arbuthnot Lane in "The Daily Mail" have been of service to readers in connection with food and preservatives. The refrigerating system has been largely adopted in areas where the power supply is readily available to preserve meat.

The references to sewage works carry our thoughts back to the days when L. Tarquinius Priscus, about 2,525 years ago, who succeeded Arcus Martius as King of Rome, set about the construction of the great sewers, still in being, of Circus Marimus, the Forum, and the Capitoline Temple. He was credited with many improvements made for the health and well being of the nation.

The Health Visitors—Conference VII—on Tuesday discussed the health and care of children, with Mrs. M. Wintringham, J.P., in the chair. "Health Visitors and Specialised Services" was the subject dealt with by N. A. Beattie, M.D., D.P.H., Willesden; "The Defective Child," by Miss H. Viney; "Inherited Defect and Incapacity," by Mrs. C. B. S. Hodson, Secretary, Eugenics Society; "Breast Feeding," by Miss K. Macpherson, Health Visitor, Hornsey.

Nine visits were arranged for in the afternoon for choice, and that which seemed of special interest was to the Ambrosia Dried Milk Works, Lifton, where we were received by the managing director and shown the various departments of the works in operation.

The milk is supplied by the farmers around, and each lot is carefully tested and only accepted when up to standard.

The milk is strained and passed through a clarifier, and from there it falls by gravity over a cooler, the temperature being reduced to 40 to 45 degrees, *i.e.*, below bacteria working point.

The drying process is very quick and simple, the milk being now passed direct through pipes and is allowed to fall over hot rollers, where it emerges like a silk curtain of pure creamy white. The film is then collected and passed through a sifter, breaking it all into powder form, and is immediately packed into tins or cardboard boxes and placed in cases ready for despatch to customers.

From the time the milk enters the Dairy Works until it is packed is only a matter of a few minutes, and the great feature of the process is the speed and cleanliness with which the work is carried out.

In the evening the Foreign and Dominion Delegates met to discuss improvements in the regions they represented.

Section A was opened by a meeting in the Guildhall on Wednesday with a discussion on "Preventive Medicine. Immunity Methods in Scarlet Fever and Measles," when the following took parts in dealing with the question: R. A. O'Brien, C.B.E., M.D., D.P.H., Beckenham; W. A. Letham, M.C., M.D., D.P.H., Ministry of Health; W. T. Benson, M.D., D.P.H., Edinburgh; J. P. Kinloch, M.D., D.P.H., Aberdeen; G. H. R. Harries, M.D., D.P.H., Birmingham, who illustrated his points by lantern slides.

Section D.—The Mayoress of Plymouth occupied the Chair, and gave an address on "Personal and Domestic Hygiene," followed by papers, from Mrs. M. A. C. Brereton, on "Clean Kitchen Management with Special Reference to preservation of Food and Destruction of Refuse"; Miss Norah March, B.Sc., Editor of "National Health," on "The Foundations of Personal and Domestic Hygiene"; by Doris M. Odlum, M.A., M.R.C.S., G.R.C.P., on "Influence of Environment on Mental Health and Development of Child"; and by Miss J. M. Upcott, Chesterfield, on "Management of Municipal Housing Estates on Octavia Hill Lines.

Conference I.—The Mayor of Plymouth opened the proceedings and Councillor A. G. H. Webb, Chairman Housing Committee, followed on "Housing," and C. Lander, D.S.O., M.C. M.B., B.Sc., Devonport, Alderman W. A. Miller, and Miss M. Bayley, J.P., joined in the discussion. "Milk and Tuberculosis" was then discussed by W. G. Savage, M.D., D.P.H., Somerset, and Councillor W. Astbury, Sheffield. "Milk Problems" were dealt with by W. Buckley, C.B.E., and R. Hall.

Conference V.—Edward Willis, Engineer and Surveyor, Brentford and Chiswick, presided and gave an address on the duties and responsibilities of engineers and surveyors. The following subjects were treated on " The Application of Reinforced Concrete to Public Health Work," by H. J. Deane, B.E., M.I.C.E.; " The Treatment of Organic Waste' '—lantern views —by W. Weaver, B.Sc., A.I.C., Birmingham; " The Effect of Improved Road Surfaces on Public Health," by W. L. Jenkins, M.A., M.I.C.E., Borough Engineer and Surveyor, West Ham.

At 3.30 Alderman Sir Fred. Winnicote received a party at " Rockville," Mannamead. The other visits were to the Beechwood Food Factory, Plymouth Electricity Works, Garden Party at " Treverlyn," Plympton, by invitation of the Mayor and Mayoress; Garden Party at Swilly Hospital, Plymouth.

A Reception was held at 8 p.m. in the Guildhall by the Mayor and Mayoress, on which occasion the attendance was up to the mark of the accommodation, and the assembly showed their appreciation of the invitation.

On Thursday, Section B, Engineering and Architecture—Chairman, John D. Watson, M.I.C.E., who gave an address on the wide subject, calling attention to several points of interest and value. F. W. Macaulay, M.I.C.E., Birmingham, gave a Paper on " Rural Water Supplies," E. J. McKaig, A.M.I.C.E., on " Falling Cliffs and Coast Erosion "; an important question, with a possible prevention cure, when we visit certain neighbourhoods and look around to see the losses that have taken place. F. C. Temple, M.I.C.E., on " The importance of avoiding ' dead pockets ' in Sewage Disposal Works." Lieut.-Colonel W. A. Vignoles, D.S.O., M.I.E.E., on " Electrical Refrigeration."

Section C. Viscountess Astor, M.P. in the chair, who gave an address on " The Value of Nursery Schools." Miss M. McMillan dealt with "Nursery Schools—the base of education" —lantern slides. Prof. W. Cullis, O.B.E., D.Sc., on " Nursery Schools "—lantern slides. Miss Mabel G. Brodie, M.B., D.P.H. on " The Welfare Centre and the pre-school child." Aleck W. Bourne, M.B., F.R.C.S., L.R.C.P., on " Recent Advances in Puerperal Fever Research."

Section G. Prof. F. T. G. Hobday, C.M.G., F.R.C.V.S., F.R.S.E., Principal Royal Veterinary College, London, Chairman. The discussion was opened after the Chairman's address by W. J. Brennan De Vine, M.C., F.R.C.V.S., D.V.S.M., Birmingham, on "Animal parasites commonly met with in meat inspection," followed by J. A. Dixon, M.R.C.V.S., Leeds; W. J. Young, M.R.C.V.S., D.V.S.M., Newcastle-on-Tyne; J. McAllan, M.A., B.Sc., M.R.C.V.S., Aberdeen; and A. Alexander, M.R.C.V.S., D.V.S.M., Salford.

Conference II.—Chairman, Councillor H. M. Medland, Plymouth, who remarked upon the vital questions which had to be considered from day to day by Port Sanitary Authorities both for the ports and the vessels using them, and that the points about to be discussed required full attention. The first item on the programme was "The Disinfestation of Ships," the opening for discussion was by A. A. Mussen, M.D., D.P.H., Liverpool, followed by "Deratisation and the International Sanitary Convention of 1926," by W. A. Daley, M.D., B.Sc., D.P.H., Hull, who referred to the Convention held in Paris, which had been to some extent brought into operation to suit the views of each country. The destruction of rats had been carried out by fumigation, generally by sulphur dioxide or hydro-cyanic acid gas. The danger arising from rats is acute in the event of a ship calling at a disease or plague-infected port and the infection being carried on board by them coming on board up the gangway. Article 28 of the Convention reads "All ships, except those employed in national service, shall be periodically deratised, or be permanently so maintained that any rat population is kept down to a minimum. In the first case they receive deratisation certificates, and in the second, deratisation exemption certificates. Governments shall make known through the Office International d'Hygiene Publique those of their ports possessing the equipment and personnel necessary for the deratisation of ship." The Port of London Authority has notified that three expert rat catchers are required to examine each ship and see that no rats are on board or that steps are being taken to exterminate them, and report to the Authority. That fumigation was costly was emphasised, and if examination and tests showed only a small number of rats, traps could be used by the rat catcher. It was quoted that a Greek vessel was fumigated at Piræus in October, 1927, the holds were empty, and 15 dead rats were found. She arrived at Hull carrying grain and linseed from Buenos Ayres on April 18th, and between then and April 30th, 236 rats were got by trapping, and by fumigation another 81 were got, 317 within six months of the fumigation at Piræus. No doubt if the vessel contains material which emits an odour tempting to rats ashore, a gangway may give means of access and allow them to get on board.

"The too high death rate of British merchant seamen and how to bring it down" was the subject given by Fleet Surgeon W. E. Home, R.N., M.D., D.P.H., in a Paper, and he in quoting from statistics, stated that 75% died from disease and more than five times greater from violence than that of all males, England and Wales, occupied and retired; that is, of the ordinary man. Is it fair on seamen that so little improvement has been made in their health as a whole in 25 years? Their deaths from accidents are very numerous. What can be done to help the sailor? 1. Put the care of his health under the Ministry of Health, which has an expert knowledge of the question. 2. As he lives in his factory (his ship) for 24 hours in each day, have that built for his accommodation under model by-laws of the Ministry, like the house of his brother in industry, and have no ship built until its plans are approved by the Port Sanitary Authority on the spot. 3. Give him more cubic space. Think of the effect of consumption.

1901-2. All have 72 c. ft. Death rate British 0·31.

Lascar 1·1.

1922-6. British have 120 c. ft. Death rate British 0·19 = 40% less.

Lascar 72 c. ft. Death rate Lascar 0·93 = 15% less.

4. Care of water supply; wash places; good galleys; good w.c.'s; drying rooms; accommodation aft. These matters require attention and should be insisted upon.

Several delegates took part in the discussions and emphasised the very great importance of improving the conditions on shipboard, those of the Mercantile Marine being the vital elements on which the nation depended to keep it going.

Fleet-Surgeon Home proposed the following resolution: "Resolved that the Council of the Institute be recommended to direct the attention to the Government to the desirability of the care of the health of the men of the merchant service being placed in the charge of the Ministry of Health." This was accepted and agreed to.

In connection with the death rate of British Merchant Seamen and reference to the difficulty of obtaining official statistics detailing the causes and the actual number of deaths per annum, the following letter appeared in "The Times" of August 8th. Fleet Surgeon Home emphasised in his paper, and the discussion which followed, the urgent need for attention to, and improvement in the conditions under which the Merchant Navy was conducted. Accommodation, ventilation at work and in quarters, food, sanitation, and thoughtful consideration to life and health:—

WELFARE OF SEAMEN.

Sir,—The Registrar-General, in his recently published Decennial Supplement, reports that, apart from his more than fourfold greater liability to death from violence or accident, the seaman's mortality from disease exceeds the average by 48·8%.

This liability to disease is, without doubt, largely due to the dangers to which the seaman is exposed when ashore owing to insanitary conditions and the absence of easily accessible medical facilities in many of the ports at which he lands, and, although figures seldom tell the whole story, yet these are truly startling.

The valuable Report prepared for the Joint Maritime Commission of the International Labour Office by Mr. J. Havelock Wilson, president of the National Union of Seamen, and Mr. T. Salvesen, the well-known Norwegian shipowner, records, *inter alia*, that "reports from all over the world are unanimous in stating that the national authorities, central and local, have done nothing to protect the interests of foreign seamen in various ports," and that "it would seem as if the law were, as a rule, allowed to be dormant in the more or less international quarters in which the seamen live."

At the International Red Cross Conference in Oslo in 1926 it was decided that it was necessary to provide, at each of the shipping ports of the world, a centre where officers and men of the merchant services of all nationalities might readily obtain information respecting facilities for medical treatment, clean and healthy sleeping accommodation, rational amusements and recreation, and also, perhaps, hospitable entertainment. In order to endeavour to meet this demand the British Council for the Welfare of the Mercantile Marine has been constituted, consisting of representatives of the various philanthropic, shipping, and seafaring organisations now in existence in this country, to discover means by which their various aims on behalf of seamen could be co-ordinated on the above lines. Much good work has been and is being done by the various bodies referred to, but the Registrar-General's figures show that a wider and more general effort is needed.

It cannot be too strongly emphasised that it is on the efficiency of this mighty key industry, the mercantile marine—or, as it is now frequently termed, the Merchant Navy—that we rely for cheap food and for the safe arrival of our mails and of the merchandise and raw materials on which the existence of every industry in the United Kingdom depends.

As a first step, the British Council for the Welfare of the Mercantile Marine has already appointed recreation secretaries in 70 ports all over the world, who are ready to assist officers and men landing from ships to enjoy such forms of healthy recreation as the port provides, or may be able to provide in the future. It is, however, chiefly by co-ordinating the efforts of the various organisations to which reference has already been made and by the co-operation of the officers and men themselves that it is hoped to be able to press forward to achievement in its fullest sense. Funds are required —not to do what is already being done so well by the organisations working in the field—but to co-ordinate and supplement their efforts.

His Royal Highness the Prince of Wales, on his appointment recently as Master of the Merchant Navy and Fishing Fleets, was graciously pleased to signify his interest in the Council and to make a donation to its funds. May I appeal to your readers to follow his Royal example? Contributions have also been received from the Shipping Federation, the National Union of Seamen, and the British Red Cross Society. Donations to the British Council for the Welfare of the Mercantile Marine may be sent to me at the Office of the Council, Carteret House, Carteret-street, Westminster, S.W.1. Cheques should be crossed "Westminster Bank."

Yours faithfully,

REGINALD TUPPER, Admiral,

Chairman, British Council for the Welfare of the Mercantile Marine

Conference IV.—Chairman, J. Howard Jones, D.Sc., M.D., President-Elect Society of Medical Officers of Health. Papers were presented by A. Eidinow, M.B., B.S., M.R.S.S., on "Investigations on the Biological Actions of Light" illustrated by lantern slides; H. S. Banks, M.A., M.B., D.P.H., on "Ultra Violet Light in Public Health Work—clinical aspect"—lantern slides. "How far Sunlight Treatment should be part of a Public Health Dept." was dealt with in a paper by W. A. Daley, B.Sc., M.D., B.S., D.P.H., Hull; and "Public Sun and Air Baths," by F. G. Bushnell, M.D., B.S., D.P.H., Torpoint U.D.C. "Cremation and the Sanitary Authority," by C. G. E. Fletcher, C.B.E., Islington. A resolution was passed to the effect that "Local Authorities should establish facilities for Sun and Air Bathing, especially for children as a means for the promotion of health and physical development."

Visits were arranged for the afternoon to Ferry Farm, Hygienic Milk Dairy, Beechwood Food Factory, H.M. Dockyard, Didworthy Sanatorium, Mount Edgecumbe Park and Orangery, and Garden Party at Admiralty House by invitation of Admiral Sir Rudolf W. Bentinck, K.C.B., K.C.M.G. The officers from the Spanish naval ship then in port were also present on the occasion and were made quite at home.

At night in the Royal Hotel, Plymouth, the Congress Dinner was held, when Prof. A. Bostock Hill, Chairman of Council of the Royal Sanitary Institute, presided. Lady Astor advocated the establishment of peace throughout the world. Close relationship was being established by delegates from all parts to overcome the enemies to health, and the banishment of war should be included in the desire of all nations. Mr. E. Willis, Con. Exhibition Committee proposed the toast "Army, Navy and Air Force," and coincided with the hope that wars should cease; but if another war did come upon the nations the contest would be in the air, and it was well to be prepared accordingly. Surgeon-Comdr. A. B. Clark, R.N., responded, and in view of the Congress and its relationship to the sanitation of all sections of the nation he desired to say with high appreciation that the Admiral-in-Chief was deeply interested in the health and welfare of the naval service men, and by co-operation their interests were well looked after.

Major-General H. P. W. Burrow, on behalf of the Army Service, said the Army was well supplied with the requirements needed for health, and the principles of sanitation and hygiene were kept well to the front. The health of the Army had been improved in the passing years. Squadron-leader G. S. Marshall also responded for the Air Force.

Dr. G. F. Buchan, R.S. Institute, Convener Examination Committee, proposed the toast of the Mayor and Corporation, and complimented Plymouth on the conditions which prevailed around to maintain health and sanitation. The Mayor, in response, referred to the historical side. In 1287 Plymouth was a naval port and had a reputation to uphold, and it was a duty to uphold a high standard to keep the trade routes open. The passenger traffic had to be considered and attended to with care and circumspection to guard against the importation of disease from abroad.

The Deputy-Mayor submitted the toast "The Royal Sanitary Institute," whose work and operations extended so far afield that the whole world ought to know the rules and advice given for health preservation. It was good for Plymouth to be chosen as the seat of the Conference, and it would be benefited thereby. Prof. Bostock Hill responded, and casting thought back to the black days when the Institute started 52 years ago, the good that had been accomplished was very pronounced. In order to train up those who could take posts as officers under Public Health Authorities, classes were started and examinations organised by the Institute. Realising also the valuable aid of women in the work, classes were available for training them in Hygiene and Welfare with a view to Health Visitors appointments. While much had been done to improve the conditions of life, there still remained much to be done.

Lady Astor, M.P., proposed "The Delegates to the Plymouth Congress," and urged that the mind and voice of the country should be spent on Peace—security for all and less touching on possible preparations for war with the questions of the means to use. The Congress was working for peace to mind and body, so that there should be health-giving conditions throughout the earth, and the delegates representing many lands were there to help. Mr. R. Nassan, Denmark; Dr. Jamshyd Mungiff, India; and Mr. W. Asbury, Sheffield, responded.

Dr. Chas. Porter, Chairman Congress Committee, expressed thanks to the Local Committee and officials who had been of help to the Congress in carrying out the local arrangements.

Sir Fred. Winnicott in acknowledging, said that the ancient parts of Plymouth and its needs as well as the newer portions had and still required heavy costs to bring the whole up to date, especially as to the drainage system, water supply and street widening. The Town Clerk (Mr. R. J. Fittall), Hon. Local Secretary, and Dr. A. T. Nankivell (Medical Officer of Health), who devoted time and energy to help on the local arrangements, also expressed their acknowledgments.

On Friday Section B was engaged with the following papers: "The Planning and Construction of Modern Abattoirs," by R. S. Ayling, F.R.I.B.A.; "Town Planning," by Prof. S. D. Adshead, M.A., F.R.I.B.A., University of London; "A Brief Review of the present condition of National Housing," by F. W. Platt, F.S.I., Manchester; "Smoke Abatement," by S. G. Moore, M.D., D.P.H., Huddersfield.

Section C Papers: "Fœtal Deaths and Fœtal injuries," by Prof. Annie L. McIlroy, O.B.E., M.D., D.Sc., Ch.B., London School of Medicine for Women; "Fœtal Deaths and Fœtal Injuries," by L. L. Cassidy, M.B., Ch.B., F.R.C.S.I., Dublin; "The Constitution and Premonitary Symptoms of the Rheumatic Child," by Flora Shepherd, M.B., Ch.B., Hornsey; "Public Health Administration in relation to Juvenile Rheumatism," by R. C. Lightwood, M.D., D.P.H., M.R.C.P., Kensington; "Rheumatic Symptomatology and Vitamin B," by Margaret Emslie, M.B., Ch.B., Croydon.

Section G. "The Planning and Construction of Modern Abattoirs," discussion opened by R. S. Ayling, F.R.I.B.A. "The Use of Mechanically-operated Instruments in the slaughter of animals for food and other purposes," by A. C. Dewbury, Royal Society for Prevention of Cruelty of Animals. Discussion followed by W. J. Brennan De Vine, M.C., F.R.C.V.S., D.V.S.M., Birmingham; Prof. R. G. Linton, M.R.C.V.S., Royal Vet. College, Edinburgh; E. J. Burndred, M.C., M.R.C.V.S., D.P.H., Blackburn; and F. L. Gooch, F.R.C.V.S., Stamford.

Conference III.—Chairman, H. Lesser, LL.B., President National Association of Insurance Committees, who gave an address on the subject of the National Health Insurance Services; "Medical Benefits: a Retrospect," by W. M. Marshall, Hon. Secretary Scottish Association of Insurance Committees; "The work of Approved Societies; Development and Activities since the Insurance Act came into operation," by S. L. Duff, C.B.E., Secretary Ancient Order of Foresters'

Friendly Society; "Treatment Benefits under the National Health Insurance Acts," by W. G. Hodgson, Clerk to Liverpool Insurance Committee; "The Sickness Experience amongst Persons Insured under the National Health Insurance Scheme," by E. F. Spurgeon, of the Prudential Approved Societies. Resolutions were proposed "That this Congress favours the extension of the scope of medical benefit and the provision of a complete dental service available to the whole of the insured population," and "That this Council is impressed with the ravages and suffering caused by cancer and malignant disease amongst their fellow countrymen and women, and recommend the Council to ask the Ministry of Health to make provision to enable Insurance Committees to promote or assist local anti-cancer centres on approved lines in conjunction with existing organisations."

The British Medical Association Conference meetings at Cardiff dealt with similar subjects, and no doubt good will result. Apropos of the papers read at Conference I on Wednesday, July 18th, on Milk, we have been faced with the Report of Dr. J. Tate, Medical Officer of Health, stating that 28 samples of milk out of 294 taken in Middlesex during 1927, gave evidence of the presence of tubercle bacilli. In 14 cases the animals responsible for infection were traced, ten being in the county.

The closing meeting of the Congress was held in the afternoon, July 20th, and at 8 p.m. a popular lecture was delivered in the Guildhall by Prof. W. E. Dixon, M.A., M.D., D.P.H., University of Cambridge, on "Poisoning in Daily Life"—illustrated by lantern views.

The 1929 meetings of the Congress are to be held at Sheffield. The members and delegates had opportunities, as time admitted, of visiting several places of interest in Plymouth as well as the Hoe, on which is a memorial of the old lighthouse—partly composed of the old Smeaton building; also the statutes as records of past years of Sir Francis Drake, Sir Walter Raleigh, The Armada, and the War Memorials to the Royal Navy and the Royal Marines. The old town with relics of the old types of houses still remaining, but soon to be no more, and the Barbican where the Mayflower recording stone is inset on the quay from which she sailed on her memorable voyage to America. The interesting Laboratory and Aquarium of the Marine Biological Association is situated near the Barbican.

Notes.

The following is from "The Board of Trade Journal" of January 26th:—

Shipping Casualties and Deaths of Seamen during 1926.—The recently issued "Return of Shipping Casualties to, and Deaths on, Vessels registered in the United Kingdom" contains a record of wrecks and other casualties which occurred during the year 1926 among vessels registered in the United Kingdom, and of deaths of seamen and passengers from accident or disease on such vessels. Some comparative figures are included for earlier years.

In the present Return deaths by disease have been classified in accordance with the short list of causes of death adopted by the Registrar-General. This list, however, has been modified by the addition of certain exotic and other diseases to which sailors are subject, and, at the same time, few diseases from which seamen do not suffer have been omitted from the list.

Excluding fishing vessels, the total number of vessels lost shows a falling off in 1926 as compared with 1925. The percentage of sailing vessels lost during 1926 was approximately 0·4 in number and 0·3 in gross tonnage of the sailing vessels belonging to the United Kingdom, while in the case of steam and motor vessels the percentage totally lost was about 0·6 in number and in gross tonnage of the steam and motor vessels owned. The following table shows the total losses and serious casualties which were recorded during the year 1926:—

Nature of Casualty.	Sailing Vessels.		Steam and Motor Vessels.	
	Total Losses.	Serious Casualties.	Total Losses.	Serious Casualties.
Founderings	5	—	12	—
Strandings	8	14	26	53
Collisions	7	28	8	39
Missing Vessels ...	—	—	3	—
Other casualties ...	1	22	10	93
Total	21	64	59	185

Of the steam and motor vessels lost 63 per cent. were vessels of under 1,600 tons gross and 37 per cent. were vessels of 1,600 tons and over, 45 per cent. of the serious casualties related to vessels of under 1,600 tons gross, 35 per cent. to vessels between 1,600 tons and 5,000 tons gross, and 20 per cent. to vessels exceeding 5,000 tons gross.

With regard to fishing vessels, the number registered under Part IV. of the Merchant Shipping Act, 1894, which were employed at some time during the year was 14,029, and of this number 51 were totally lost and 72 suffered serious casualties, (*i.e.*, casualties, other than total losses, involving serious risk or material damage to vessels).

Deaths of Seamen.—The following table shows the number of deaths among the crews of sailing, steam and motor vessels (other than fishing vessels) during 1926:—

Cause.	Deaths at Sea.	Deaths in River or Harbour.	Total.
	No.	No.	No.
Casualty to vessel	191	23	214
Other accidents :—			
On board	98	137	235
Ashore	—	102	102
Disease	242	502	744
Homicide and suicide	44	15	59
Total (including lascars) ...	575	779	1,354
Lascars	125	182	307

Of the total number of deaths 15·8 per cent. were caused by casualties to vessels and 24·9 per cent. by other accidents; 54·9 per cent. were due to disease and 4·4 per cent. to homicide and suicide. Tuberculosis accounted for 14·7 per cent. of the deaths from disease, pneumonia (all forms) for 14·0 per cent. and heart disease for 11·3 per cent. Of the deaths from disease, one-third only occurred at sea while, of deaths from other causes, 55 per cent. occurred at sea.

Deaths among members of the crews of fishing vessels totalled 95. Of these 39 were due to casualties to vessels, 46 to other accidents and 10 to disease.

Deaths among passengers in vessels, other than fishing vessels, numbered 885 during the year. Of this total 815 died from disease, 21 from accidents (including casualties to vessels) and 49 from other causes.

*The Board of Trade notice to Shipmasters issued by the Ministry of Health on Fumigation of Ships by Hydragen Cyanide, states that it is a dangerous process which should be undertaken only by responsible persons with full knowledge of the nature of the gas and of the necessary precautions. The following are the points emphasised in the note of warning:— The nature of the gas. Hydrocyanic acid or prussic acid gas. Warning notices for safety at every gangway. Preliminary search for unauthorised persons for their safety. Ventilation, after fumigation to make sure all gas is cleared off with special attention to sleeping accommodation and bedding. Symptoms of poisoning for guidance in use of appliances. Rescues and how to protect and remove sufferers. First aid and best means to apply.

Sir Alan G. Anderson, President, attended a meeting of The Royal Aeronautical Society on May 10th, when a lecture was delivered in the Royal Society of Arts Hall by Mr. B. N. Wallis on "Design and Construction of Modern-rigid Air ships."

When discussing the subject he pointed out that it could not reasonably be expected that the undertaking of commercial aviation could be weighed in the early days of its youth with advantage from an economical standpoint. It was, however, apparent that comfort for the passengers and a speed of 75 miles per hour were on the good side, and would call for high fares being readily met due to time saving. The main point was to keep on the safety line, and it was the important one, rather than economy in structural work and operating costs, these might follow later when experience had been gained to show the way.

In the "Mechanical World" of May 11th there is an interesting description with illustrations of roller bearings which were planned, tested and developed in steel mills, where the saving in power and time were of considerable advantage. Steel rolling mills for the roll necks of the bearing, consists of two double cones or lower races, four sets of tapered rollers with individual cages, and three cups, one of which is double. The assembly is a simple 3-part operation, the caps, cones and rollers being all assembled inside the bearing chuck. The complete assembly may be slipped on and off the roll neck as a unit without disturbing the bearing adjustment.

* H.M. Stationery Office, dated June, 1928. 1d. each copy.

The following is from "The Shipping World" of June 20th, in which issue is also a report of the Conference which was held in the Drapers' Hall, London, from June 12th to 15th. The proceedings have also been reported in other journals, and in "The Shipbuilding and Shipping Record" of June 14th the countries represented and the names of the delegates are given.

SAFETY OF LIFE AT SEA.—One of the most effective speeches delivered at the International Shipping Conference was that by Sir Alan Anderson, who dealt with the question of Safety of Life at Sea. He referred to the first clause in the report of the International Committee, dealing with boats and life-saving appliances, which reaffirmed the resolution adopted seven years ago. Sir Alan stated that they started off in the best possible way by pointing out the practical infallibility of their own judgment. He said:—

What we said seven years ago has stood the test of time, and those Governments which have closely followed on the recommendations of this Conference have been justified by the results. As to the future, it is not wise as a general rule to restrict the number of passengers on board all ships to the number of boats that can be so carried, and we hold with still greater force the view that it is perfectly ridiculous to insist upon boats being carried which cannot easily be launched and which by their position cumber up the decks and prevent the rapid launching of boats which would otherwise save life. It is not easier to launch a large boat than a small boat, but it is easier to launch a smaller number of large boats than a large number of small boats.

In clause 3 of the report we touch upon davits and the list which it is necessary to assume for a disaster. It may seem a small thing to a Government regulating the Mercantile Marine to assume a list of 15 degrees instead of 10 degrees, but all of you who realise that a boat to be safely launched must take the water from any of the decks above the water line when a boat has this assumed list, will see that if the list is assumed to be 15 degrees, a long and strong davit of great weight and difficult in handling is required. What is the virtue in 15 degrees? Why not 30 degrees? If a ship once begins to take a heavy list, there is no reason to suppose she will stop as 14 degrees or 15 degrees if she is in a very bad way. Then in paragraph 4 we say it is not possible to maintain in good condition searchlight and wireless apparatus in lifeboats and that therefore they should not be so fitted. The master of a ship in disaster has an extremely difficult and perilous job to undertake, and it is not fair to supply him with material which, in our opinion, will probably not be in good order in an emergency. If it is not in good order, he is certain to be blamed. We think, therefore, that the material provided under regulation for these life-boats should be of the simplest character. In regard to stores, it is not any excess of economy which makes us object to putting additional stores in boats, but the same prudent view that the equipment and store of life-boats should be of a simple character. If any emergency occurs and people have to take to boats for a long voyage, they will supply those boats as well as they can and as conveniently as they can for the emergency they have to meet.

In the matter of fire-extinguishing appliances we support the instructions issued by the British Government to their surveyors in their circular of 1926.

Transportation Risks.

Sir Alan referred to the methods of payment for transport and the subsequent effect in the event of a forced reduction in any of them. His opinion was that it would tend to make for more risky transportation. He added :

The view of the shipowners is that you must not go to extremes; you must not get hysterical. The world has to pay for transport and it can pay in any one of three kinds: it can pay in money or in time or in risk—convenience or inconvenience. If you make an hysterical attack in order to reduce one of those payments, supposing the shipowners were to reduce all their charges for transport, the inevitable result would be that transport would be very much slower or perhaps more risky. If our Governments regulated the time and said all shipowners must carry their passengers much more quickly, the payment in coin would have to be put up enormously, with increase in risk. But those two they leave untouched, and the Governments, quite naturally with public opinion behind them, have attacked the one payment in risk, and they have said we must do all we possibly can to reduce the risk of transport, and so they propose these resolutions. We who know something about the sea can get what I believe is a true perspective of the risk. We know how very small it is; it cannot ever be done away with altogether.

How Safe is Travel by Sea?

It is quite possible, he continued, to make transportation so expensive that no one would travel. It is quite impossible to make it so safe that no one will ever lose life. But how safe is it? It is very difficult to get an accurate picture. But we have some evidence. Here, for instance, is the leading Danish passenger line reporting 350,000 passengers carried yearly and no lives lost in the last five years. The Swedish Board of Trade has no records regarding passenger lists except in the three years 1920, 1921, and 1922. In those years one passenger was lost in one year, one in another, and six (but not in overseas trade) in the third. During the last five years no calamities or accidents have been brought before them in which passengers lost their lives; neither in the same period any cases in which those on board passenger vessels had to leave the ship in boats. I have from the statistician of the Chamber of Shipping some rather interesting figures regarding British shipping. He has gone back 55 years, so he has burdened his figures with rather heavy losses from sailing ships in the early years. In all that time there were 4,000,000,000 passenger miles run and 200 passengers drowned. So one passenger was drowned for every 20 million passenger miles. That conveys to me literally nothing. I do not know if it means anything to you, but I have tried to turn it into something comprehensive.

If Christopher Columbus had Lived

So that he might give an adequate description of the chances of loss of life of passengers by drowning, Sir Alan made some very interesting humorous comparisons. Describing Christopher Columbus's chances of drowning, according to figures supplied by the Chamber of Shipping, Sir Alan pointed out:

I find that 436 years ago Christopher Columbus made a memorable voyage to America. That voyage was about 3,000 miles. If Columbus had survived till now he would obviously have travelled 16,000,000 passenger miles, and he would be due to be drowned in another 4,000,000 passenger miles. I do not want to suggest to you that the sea is free from risk. In fact I rather hesitate to give you these figures because they look so safe, and I know that if ever we do anything that seems boastful, disaster happens; so please do not think I am boastful. I have been in the habit of sailing about in small boats all my life, and I have probably been shipwrecked more often than any of you. Here are some extraordinary figures about the last five years, which have been exceptionally good years for the British Mercantile Marine. In the last five years, assuming the same passenger miles 9·6 passengers have been drowned in those 4,000,000,000 passenger miles. That means, roughly, one every 400,000,000 passenger miles.

Columbus could not have travelled long enough to earn his drowning. So I have looked further back in history and I find that Saul, the King of Israel, lived 1,000 years B.C. That is not long enough back. Mena, the first known King of Egypt lived 5,000 B.C., and if he had made twelve voyages a year—that is one a month—for 7,000 years of 3,000 miles each, he would have gone 252,000,000 passenger miles, whereas he has to go 400,000,000 to get drowned. (Laughter.) That gives you some comparative idea of the risk that you are trying to meet by all this elaborate equipment. I think it is ridiculous that our Governments should get hysterical over risks of the order that I have described to you. I think that the method of regulating as proposed by the Committee is amply sufficient for all considerations of good business and humanity.

CHROMAR CONDENSER TUBES.—Messrs. J. Stone and Co., Ltd., Deptford, have, in their latest development, gone a long way towards eliminating condenser tube trouble by the production of condenser tubes having an integral surface of pure chromium, which is undoubtedly one of the best metals for resisting all forms of corrosion and erosion. These are manufactured by the "Chromar" process. It is demonstrable that Chromar tubes have a heat conductivity superior to that of other condenser tubes. This means a smaller condenser with the consequent saving of weight and space, reduction in the size or capacity of the circulating pumps, and a more efficient condenser. The tests which have been carried out upon the Chromar tubes have been extremely severe. Firstly, specimens of tubes of all known manufacture obtainable were suspended in sea water, part of each specimen being left exposed to air in order to obtain the "between wind and water effect." At the end of each month thereafter each specimen was carefully cleaned, examined, and weighed. It was found that Chromar tubes were the only ones unaffected by the test. All other tubes had become affected in varying degrees.

In brief, there are three points of outstanding interest and importance in Chromar condenser tubes. (1) The deposit on the tubes is pure chromium metal which does not oxidise, and therefore should not corrode; (2) the tubes have a heat conductivity superior to that of other condenser tubes; and (3) water does not wet pure metallic chromium.

It is pleasing to note that John T. McIntyre, Falkirk, Lloyds Register Scholarship holder 1925-8, who has been attending the Glasgow Technical College, has passed the external examination for the London degree with 1st Class Honours.

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Books added to Library.

Purchased:—

Report of an Enquiry into Apprenticeship and Training for the Skilled Occupations in Great Britain and Northern Ireland. 1925-26. No. VII. General Report. Published by H.M. Stationery Office, 1928.

Report on the Examinations of Candidates for Certificates of Competency in the Mercantile Marine for the year ending December 31st, 1927. Published by H.M. Stationery Office, 1928.

Occupations Census of England and Wales, 1921. Published by H.M. Stationery Office, 1924.

"Diesel Engines for Land and Marine Work," by A. P. Chalkley. 6th Edition. Constable & Co.

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Boiler Explosion Acts.

REPORT NO. 2843. S.S. *Baron Ailsa*.

The investigation of the cause leading to an explosion in the port boiler of the *Baron Ailsa* was conducted by Mr. J. Dow, Board of Trade Surveyor, Glasgow. The boilers were of the three drum type—Stirling boiler—steam pressure 180 lbs., and during the voyage from July, 1926, in order to provide a means for dealing with leaky tubes which would require to be stopped up at the ends, nipples were obtained, made of solid drawn steel 6in. to 8in. long, $2\frac{1}{4}$in. outside diam. x 8 I.W.G. thick. One of these nipples had been used and gave way. It was plugged at one end by a mild steel flat disc, welded circumferentially throughout its thickness of $\frac{3}{4}$in. to the inner surface of the tube. The nipple had been fitted during the voyage at the water drum of the boiler on account of a leaky tube which had to be removed and the hole in the drum plugged with the nipple. On December 9th at about 3 p.m., while the vessel was on the way from Fayal to Lisbon, the nipple was blown out from the water drum tube end and the water contents escaped into the stokehold. Very unfortunately a fireman was severely scalded and was hauled up the ventilator by a rope; he was taken to the hospital at Ponta Delgada, where he died.

It was considered that the nipple was unreliable in construction, and evidence was lacking to prove that the welding of the plug was efficiently done; it had been blown out and away and not found afterwards. There were 470 main tubes, $2\frac{1}{4}$in. diam. The two front rows were 8 I.W.G. thick, and the others 9 I.W.G. The total grate surface of the two boilers was about 135 sq. ft. and the total heating surface 5,110 sq. ft.

The Chief Engineer joined the *Baron Ailsa* in July, 1925, made two voyages and on July 12th, 1926, at the beginning of the voyage, no nipples had been necessary to replace tubes. Among the stores carried on board there were about 24 nipples supplied by the makers to be ready in case of the tubes giving out. These were made by a process of pressing out of a flat plate so that the nipple was in one piece, with hemi-spherical shaped closed end, but with the complete avoidance of welding of any description. It may be stated that this is the type that the makers of the boiler always supply when necessary.

A survey of the boilers was made at Antwerp in July, 1926, and a satisfactory hydraulic test was also witnessed in each case. The second voyage extended from July, 1926, to February, 1927. It appears that during the previous voyage of about seven months, on the way home the tubes in the outer and adjoining rows began to give trouble. Pin holes were found and leaked at various points of the tubes, mostly at the lower ends near the water drum. Clips or glands were made and fitted at sea as necessary and the bad tubes were cut out and replaced by new tubes at Antwerp.

On the second voyage the tubes began to leak at pinholes and blisters, which formed cracks in No. 1 row tubes next the fire. Clips were fitted at sea and the bad tubes were cut out and replaced by nipples when the vessel had arrived in Norfolk, Virginia. The nipples made in one piece with hemi-spherical shaped closed end in the ship's store were rusty and pitted and only a few of them were considered fit for use. New welded nipples were made from boiler tubing by the Southern Shipyard Corporation, Newport News, and were fitted in place of the worst of the defective tubes in the No. 1 rows of the boilers. In addition about one dozen spare welded nipples were supplied to the ship by this firm. The voyage took place during the coal stoppage, and it appears that the speed of the vessel was adversely affected by bad coal. Moreover, when tube repairs were made at sea the vessel proceeded under only one boiler during the interval required to blow down, repair, refill from the sea and raise steam again on the other boiler. In order to ensure command of a good head of steam going up the St. Lawrence a call was made at Sydney, Cape Breton, for further tube repairs. Spare boiler tubes from the ship were used by the Sydney firm and more welded nipples were made and fitted to the boilers. About eight spare welded nipples were also taken on board at this time.

At Montreal a further supply of welded nipples was made and fitted to the No. 1 tube row in each boiler until these two rows were closed with nipples and no complete tubes left in either of them. On the 29th October after completing repairs a satisfactory hydraulic test to 210 lbs. per square inch was made on each boiler. At the same time about one dozen spare welded nipples was taken on board. On the 24th November the vessel called at Fayal for coal. There was very heavy weather on the voyage across the Atlantic and this served to accentuate the continued difficulties, arising from tube repairs and bad coal, or maintaining a satisfactory speed.

All the tubes in the No. 2 row of each boiler were replaced at Fayal with welded nipples made and supplied by a local firm. The vessel left Fayal on the morning of the 9th December and the boilers worked well until about 4 p.m., when one welded nipple on the No. 1 row of the water drum of the port boiler failed at the circumferential weld and the water was blown out of this boiler and one fireman was seriously injured. A call was made at Ponta Delgada where Dorst, the injured fireman, was landed and taken to hospital on the 10th December. The nipple which failed was cut out and replaced at sea by another of the same description. The vessel left Ponta Delgada for Lisbon on the 11th December. After the explosion the main boiler safety valves were adjusted to blow off at 120 lbs. per square inch instead of 180 lbs., which was the normal pressure of the boilers. Head winds and very bad weather were encountered, the coal was bad and the nipples began to leak at the weld. For a considerable part of the time the vessel now proceeded under one boiler only while defective nipples as well as tubes were replaced, and all the spare nipples on board were used up. Defective tubes and nipples were afterwards replaced when necessary during the voyage by fitting steel plugs a driving fit from the inside of the drums so that the boiler pressure could not displace them from the holes.

The vessel was compelled to return to Ponta Delgada for coal, arriving there on the 22nd December. The opportunity was taken while in this port to replace all the nipples in both boilers with solid steel plugs fitted with a slight taper and driven into the holes from the inside of the drums. This repair greatly improved the situation on board, and very much better progress was made during the remainder of the voyage, which ended at Sunderland on 3rd February, 1927.

The two Stirling boilers were there replaced by new Scotch boilers. The old boilers were removed from the vessel before I had an opportunity to make inspection of them.

Observations of Mr. A. E. Laslett,

Engineer Surveyor-in-Chief.

This case illustrates the difficulties which are experienced in working water tube boilers on board a cargo vessel in the general carrying trade. It is necessary with such boilers to use fresh feed water, free from those scale forming impurities which are to be found even in town supplies, and in the type of vessel described such a pure feed supply cannot be obtained.

Experience in working such boilers is also not often possessed by the engineer officers in such ships. The use of impure fresh and sometimes even of sea water resulted in this case in constant trouble with the tubes, so that the supply of nipples intended for plugging holes from which defective tubes had been removed was exhausted, and those supplied by foreign makers proved to be, in one instance, defective. The water tube boilers have now been replaced by boilers of the ordinary cylindrical marine type.

REPORT No. 2,883. S.D. *Cavalier*.

The *Cavalier* is a steam drifter of 107 tons gross, of Peterhead. She is fitted with a single-ended steel boiler 9ft. 6in. x 9ft., with two plain furnaces, steam pressure 140 lbs., the upper and lower manholes each being 16in. x 12in. The lower door was of the McNeil type and on August 8th, 1927, an explosion occurred through this doorway when the drifter was about one mile to the east after leaving Peterhead. An investigation of the cause with the Report was made by Mr. W. L. Mennie, Board of Trade Surveyor, Aberdeen. On August 7th, after the boiler had been emptied and cleaned the bottom manhole door was rejointed and the boiler filled. The fires were then set away and at 8 p.m. they were banked for the night preparations made for leaving next day at 11.45, and at mid-day the door joint failed without injuring anyone, and the drifter made her way back to port. Examination of the doorway showed wastage of the plate and of the door by corrosion, and with the door placed centrally the clearance between the door and the opening was $\frac{3}{8}$in., measured at the place where the failure occurred. Early in 1925 the Supt. Engineer left the owner's service, and the boiler had not been officially inspected since, otherwise the condition of the door and doorway would have been seen to and the failure avoided with the expense involved.

The observations of the Engineer Surveyor-in-Chief were that the boiler was of considerable age—20 years—it had not been examined by any competent person for more than two years, although insured by an Insurance Company. It was reasonable to suppose that if the manhole had been examined during the 12 months prior to the explosion, the need for repairs would have been discovered and the repairs made. The fireman had, fortunately, left the stokehold, just before the joint blew out, or he might have sustained serious injury.

REPORT No. 2,887. S.S. *Sappho*.

Report No. 2,887 deals with an explosion from a manhole door of the boiler on the S.S. *Sappho* on August 24th, when proceeding seawards between the breakwaters at Portland; no one was injured. The boiler was steel, 15ft. diam. x 10ft. 6in. with three corrugated furnaces, steam pressure 160 lbs. There were two manhole bottom doors, one on each side of the centre furnace, each 15$\frac{7}{8}$in. x 11$\frac{7}{8}$in., with a compensating ring riveted to the front plate around the manhole. The door was made by riveting two plates together, one plate being of the size of the hole thus forming a spigot. There were two bolts $1\frac{1}{4}$in. diam. for securing the door. The door on the righthand side of the furnace was renewed in January, 1926, and it was the one that caused the explosion on August 24th, 1927.

The examination as to the cause, with the Report, was made by Mr. I. A. Oxberry, B.T. Surveyor, Bristol, who found that a portion of the jointing material of the manhole had been displaced, due to the inner edge of the hole being worn, the spigot also being defective.

On May 31st the boiler was surveyed, and on July 6th steam was raised and the vessel proceeded on her voyage, on the following voyage she left Bristol on August 16th, calling at Swansea on the 19th for the Continent; on the 21st a leakage occurred in one of the combustion chambers and it was deemed prudent to put into Portland, which was near at hand, for examination and repairs necessary. The boiler was emptied, examined, and the repair to the combustion chamber made. The manhole doors were rejointed with asbestos rings 1in. wide. The boiler was refilled, steam raised and the voyage proceeded with soon after noon, and the joint of the door blew out about 12.40, leading to another return to Portland. The Chief Engineer stated that there was a flat on the spigot where the failure of the joint took place, and it extended about 3 ins. leaving an opening between the spigot and edge of the front plate of about $\frac{1}{4}$in. He was not on the ship when the door was renewed, but there had been no leaking from it till the joint burst out and the only reason he could assign for the defect was that it had been badly fitted in the first place, the partial flat had been built up with electric welding. In rejointing the door after the explosion, the spigot was not placed central to the manhole, but kept towards the position of the leakage so that the opening between the spigot and the edge of the front plate at that place was a minimum. The asbestos ring joint was similar to the former one used. No trouble was experienced, and after arrival at Rotterdam, the spigot was built up and a joint $1\frac{1}{2}$in. wide was fitted.

When the manhole was examined by Mr. Oxberry he found the inside edge of the plate was worn round, especially on the lower part, where the joint failed. The lower part is subject to friction owing to the door grating upon it when being removed and replaced; also when a rake is used to clear the bottom of the boiler. The rounded inner edge of the front plate, together with the flat on the spigot at this position would cause only about $\frac{3}{8}$in. of a joint 1in. in width to be effectively gripped when the door was central in the manhole. It appeared to have been through good fortune alone that trouble in keeping the door tight was not previously experienced. It was decided to have the front plate built up with electric welding, and the door refitted and the use of the $1\frac{1}{2}$in. joint instead of the 1in. width.

The observations of the Engineer Surveyor-in-Chief were that the inner edge of the end plate and the flat surface of the door were worn to such an extent that it was difficult to make a good joint. The condition of such doors is often over-looked when the boiler is being examined, but it is very necessary, especially in old boilers—the one in question was 27 years old—that attention should be given to ensure that they are not worn or wasted by corrosion.

Report No. 2900. T.S. *King George V.*

This deals with the explosion on the turbine steamer *King George V*, about 12.10 p.m. on September 29th, 1927, and resulted, unfortunately, in the deaths of two firemen after they had been taken to Kilmarnock Infirmary. The investigation of the circumstances was conducted by Mr. Garnet E. Jenkins, Board of Trade Surveyor, Glasgow.

The boiler from which this explosion took place is the forward one of two coal-fired Yarrow patent high-pressure water-tube boilers. It consists of a forged steel steam and water drum 11 feet long over the ends and 3 feet 6 inches internal diameter. This is connected to three forged steel water drums by means of straight tubes which are expanded and bell-mouthed into the drums. Each of these three water drums is 18 inches internal diameter. The fire grate is situated between the nests of tubes connecting the saturated steam and water drum to the two lower water drums (See Plate I). A Yarrow superheater is placed between the two water drums on the right-hand side of the boiler. The generating surface of the boiler is 2,550 square feet, while that of the superheater is 870 square feet.

The usual necessary mountings are fitted, a stop valve and safety valves being placed on the superheater drum, while the automatic and hand-feed regulating valves, auxiliary stop valves, sentinel safety valve, and water gauges are fitted on the saturated steam and water drum.

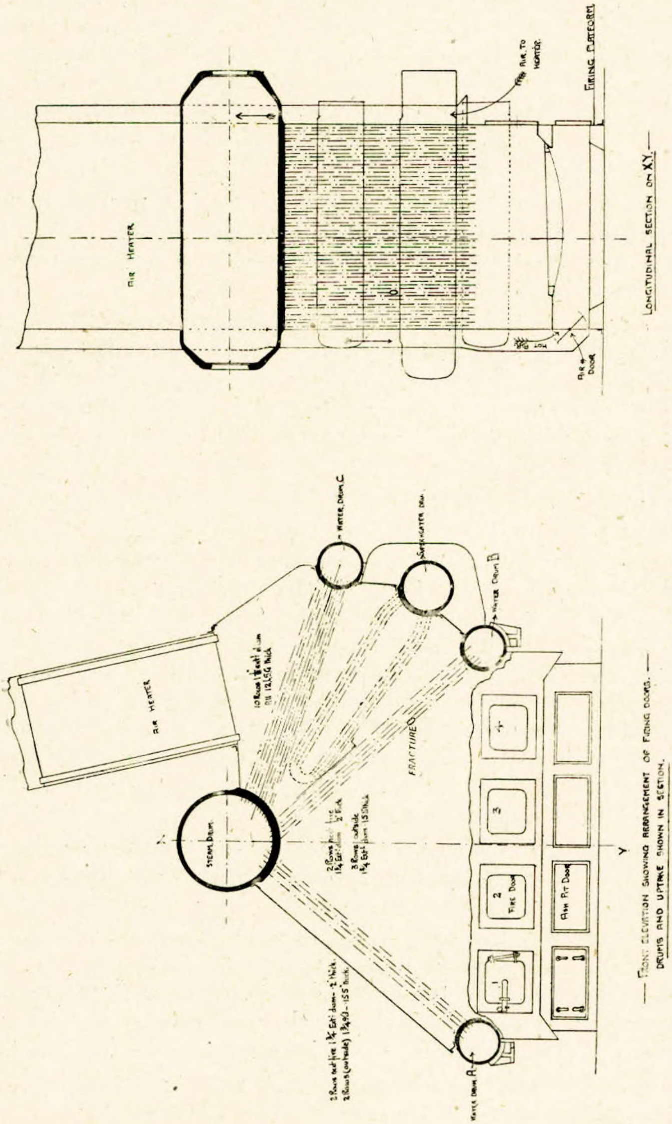


Plate I.

The sizes of the tubes connecting the saturated steam and water drum to the water drums are as shown on Plate II. These tubes are of solid drawn steel, cold finished, and were made by The Perfecta Steamless Steel Tube and Conduit Co. (1923), Ltd., Birmingham. They were inspected and tested by the Board's Engineer Surveyors before being put in the boilers. Each tube was hydraulically tested by the tube makers to 1,500 lbs. per square inch, and the completed boiler was subsequently tested by the Board's Surveyors by water pressure to 913 lbs. per square inch.

The spring loaded safety valves on the superheater were adjusted to lift at a pressure of 575 lbs. per square inch, while the safety valve on the saturated steam and water drum lifts at 590 lbs. per square inch.

The boiler room is closed, and is under air pressure, cold or outside air being supplied by a fan. This cool air is preheated, and after heating passes down the back of the boiler into the closed ashpit to the firebars. The products of combustion pass up the right-hand side of the boiler and through the air heater to the funnel.

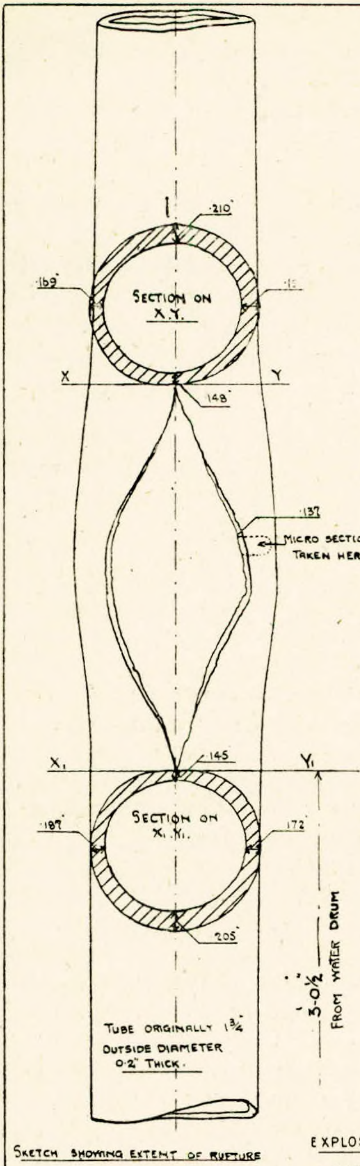
Drenchers are fitted so that the fires may be rapidly extinguished by water in case of an emergency.

The boiler was inspected internally and externally by the Board's Surveyor and by the Superintending Engineer, Mr. Charles Murdoch, at the survey for renewal of the passenger certificate on the 11th February, 1927. On the 17th July, 1927, the doors of all the drums were opened and an examination of the interior made as far as possible, from the outside, by the Chief Engineer and Mr. Murdoch. No examination of the tubes internally was made as the boiler had been blown down the night of the 16th July, and had to be ready for service on the morning of the 18th.

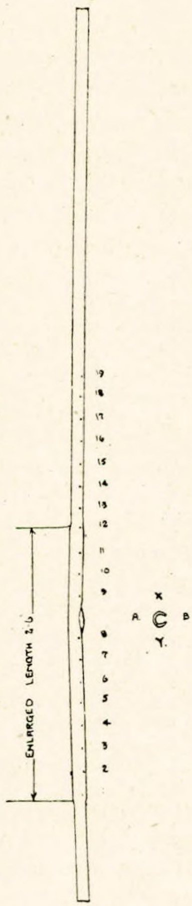
On the 3rd August, 1927, an inspection of the superheater under service conditions was made by one of the Board's Engineer Surveyors.

The Chief Engineer made an external examination of the boilers each week-end after the tubes had been swept. Mr. Murdoch and he made the examination on the 18th September, while the Chief Engineer made the inspection on the 25th September. The results of these inspections were satisfactory.

There was a dull report when the explosion occurred, and Nos. 1 and 2 furnace doors were forced outwards by the con-



Sketch showing extent of rupture



Outside Diameter of Tube.

Station	Axis X.Y.	Axis A.B.
1	$1\frac{25}{32}$″	$1\frac{3}{4}$″
2	$1\frac{7}{8}$″	$1\frac{7}{8}$″
3	$1\frac{7}{8}$″	$1\frac{7}{8}$″
4	$1\frac{29}{32}$″	$1\frac{29}{32}$″
5	$1\frac{29}{32}$″	$1\frac{29}{32}$″
6	$1\frac{7}{8}$″	$1\frac{7}{8}$″
7	$1\frac{27}{32}$″	$1\frac{27}{32}$″
8	$1\frac{13}{16}$″	$1\frac{27}{32}$″
9	$1\frac{27}{32}$″	$1\frac{7}{8}$″
10	$1\frac{25}{32}$″	$1\frac{13}{16}$″
11	$1\frac{3}{4}$″	$1\frac{3}{4}$″
12	$1\frac{3}{4}$″	$1\frac{3}{4}$″
13	"	"
14	"	"
15	"	"
16	"	"
17	"	"
18	"	"
19	"	"

(REPORT No. 2900.)

EXPLOSION FROM A WATER-TUBE BOILER ON BOARD TURBINE STEAMER "KING GEORGE V." N.O. 148912

1168. 16*6, 500 2/28

Malby & Sons, Lith.

cussion and escaping steam. The fifth tube from the after end of the boiler (*i.e.*, the end remote from the firing door) in water pocket B in the row nearest the fire ruptured longitudinally, as shown on Plate I. Through the aperture a part of the contents of the boiler escaped.

The position of the aperture was on the side of the tube nearest the fire and 3 feet ½ inch from the water pocket.

The explosion was caused by scale on the inside of the tube, resulting in overheating and consequent rupture of the tube.

The boiler was the forward one of two Yarrow patent high-pressure water-tube type which supplied steam at a pressure of 550 lbs. to the main propelling and auxiliary machinery. Each boiler was fitted with a superheater, the final temperature of the steam after superheating being 750 degrees Fah. Feed water is carried in tanks forward of the boiler room, the water losses being made up each day by filling from the Greenock town main water supply. An evaporator forms part of the installation, the intention being to put the town's water through the evaporator and thereby supply the boiler with distilled water. When the feed tanks were partially empty, difficulty was found in feeding the evaporator, and consequently town's water had to be taken direct from the feed tanks, without evaporating it, to make up the losses.

An electrical salt detector is fitted, which indicates any leakage of salt water into the feed system. At no time did this show more than half a grain per gallon of impurities while the boilers were on service.

The vessel plies on the Clyde during the summer months and first came on service in September, 1926, when the season was a short one. After undergoing extensive builders' trials in December, 1926, the vessel was laid off for the remainder of the winter. In February, 1927, the boiler was surveyed by one of the Board's Engineer Surveyors for renewal of the passenger certificate, and was found to be in satisfactory order. Prior to carrying out trials in April, 1927, the opportunity was taken to coat the whole of the internal surfaces of the drums and tubes with a preservative with the object of preventing corrosion.

The vessel had intermittent periods of service during May and went on regular service for the season on the 23rd May, 1927. For the season the total steaming time of the boilers was approximately 107 working days.

Beyond the weekly cleaning and external examination the boilers were not seen internally until 17th July, when the drums were inspected, as previously mentioned, by the owners' Superintendent and by the Chief Engineer and found to be in satisfactory order.

The conditions of working the boiler are as follows:— At 5 a.m. the steam on the boilers is at a pressure of about 200 lbs. per square inch, and this is gradually raised to 350 lbs. when the auxiliaries are started. The machinery is warmed through and steam raised to about 525 lbs. for working the vessel to the departure pier which is left at 8 a.m. The full pressure of 550 lbs. is kept on until 7.30 p.m., at which time, unless there is an evening cruise, the day's work is finished. Steam is then worked back to about 300 lbs., the water being pumped up to the top of the gauge glass and the fires made up for the night. Before commencing to raise steam on the boilers, the water which has condensed in the superheater during the night is drained off to the feed supply tank.

On an average 7 lbs. of lime, in the form of lime water, was put into the feed tank each week the vessel was on service, while periodical tests of the feed water for acidity were made.

On the 29th September the vessel proceeded from Greenock to Irvine to lie up for the winter. She arrived off Irvine Bar about mid-day and "stand by" had been rung down from the navigating bridge telegraph to the engine room. The Chief Engineer, Mr. John Whyte, who holds a First Class Certificate of Competency, then rang the boiler room telegraph to "stand by" and was answered from the boiler room. Prior to this he had issued instructions that the fires were not to be allowed to become too low, as steam was required for pumping purposes after the vessel had been moored. Both firemen were on duty in the boiler room at the time, James Bryson firing the forward boiler and Edward Kane the after boiler. The Third Engineer, Mr. Peter McIntyre, who holds a First Class Certificate of Competency, was responsible under the Chief Engineer for the working of the boiler room. Mr. McIntyre left the boiler room at 12.10 p.m. and went to the engine room to assist with the machinery while the vessel was working into harbour. When he left the boiler room the water in the water gauges was $\frac{5}{8}$ths glass, the steam pressure was about 525 lbs. and all was working satisfactorily. On reaching the engine room the telegraph from the bridge rang "stand by," but before Mr. McIntyre had time to go below into the engine room the explosion occurred. The concussion blew off a manhole lid in the port alleyway and this alleyway and the upper part of the engine room filled with steam. Realising that there was something seriously wrong, the Chief Engineer accelerated the fan to clear the boiler room of steam, while the Third Engineer accelerated the main feed pump and started the reserve feed pump on to the boilers so as to reduce the steam pressure. The Chief Engineer then went along the port alleyway and turned on the drenchers to both boilers so as to put out the fires and stop the generation of steam. On looking through the glass port in the air lock door he saw Kane and assisted him out into the alleyway. The Chief Engineer was then lowered through the manhole into the boiler room in an endeavour to find Bryson, but the intense heat of the steam made it impracticable for him to stay down. During the short time below he ascertained that the steam was coming from the forward boiler. Almost immediately after the Chief Engineer was drawn out of the boiler room, Bryson was seen through the manhole by a trimmer, who called on him to come up the ladder. Bryson was able to do so, and after being assisted out both he and Kane were given first aid on board. A doctor was brought out from Irvine, and when the vessel got into port both men were taken to Kilmarnock Infirmary where they subsequently died.

After Bryson came out of the boiler room it became possible to enter it and Mr. Whyte went down. He saw steam blowing out of Nos. 1 and 2 firing doors on the forward boilers, both doors being open. The main and auxiliary steam stop valves and the feed check valves on the forward boiler were then shut off. There was still 100 lb. steam pressure on the after boiler, but the steam in the boiler room made it impracticable to ascertain the water level in either of the boilers. In the circumstances it was judged imprudent to raise steam on the after boiler, and the steam pressure being now insufficient to operate the drenchers the extinguishing of the fires was completed by hand. From the time the explosion took place until the fires were extinguished was approximately six minutes.

I made a preliminary external examination of the boilers, the boiler rooms and the boilers having been left undisturbed after the explosion. There was a quantity of partly burned coal and ashes on the floor which had been ejected from the grate of the forward boiler by the explosion. Nos. 1 and 2 fire doors were closed but not latched, whilst Nos. 3 and 4 doors were closed and securely latched. A firing shovel had been found lying beside No. 1 door. These doors are so hinged as to be self-closing Catches are also fitted so that in the event of a tube bursting the doors could not be forced open. It was part of the ordinary routine to latch each door after the coaling of that particular fire had been completed. When the fireman on No. 1 boiler was firing, the fireman on No. 2 boiler assisted him by opening and closing the furnace door as each shovelful of coal was put in. This ensured the door being open for the shortest possible time. I tried both Nos. 1 and 2 doors. No. 1 door closed and latched properly, while No. 2 door closed but the door would not shut close enough to allow the latch to engage in the catch. It is stated that when the vessel left Greenock all the doors were in good condition and could be properly latched.

On going inside the furnace I found that the fifth tube from the after end of the boiler connecting the steam drum to water drum B and in the row next the fire had ruptured longitudinally. The opening was 3 feet $\frac{1}{2}$ inch from the water drum, and was in such a direction as to discharge the steam and water across the grate. The extent of the rupture is as shown on Plate II, being $4\frac{3}{8}$ inches long and 1 9/16th inches maximum width. This tube had been forced back by the explosion against the tubes in the second row. The sixth tube in the first row was slightly bulged in two places, while a number of the tubes at the after end of the row drooped towards the fire. The fire in way of Nos. 3 and 4 doors was practically bare of coal or cinders.

In view of the shovel having been found near No. 1 furnace door of the forward boiler and of instructions being issued to the firemen not to allow the fires to become too low, it is probable that Bryson was firing the forward boiler through No. 1 door and that Kane was attending to the opening and closing of the door. Bryson would therefore be in front of No. 1 door and Kane in front of No. 2 door. No. 1 door would not be latched, and No. 2 door, although closed, could not have been secured. When the tube ruptured the concussion forced Nos. 1 and 2 doors open and both men would be directly in the bath of the escaping water, steam and burning coal. Bryson's injuries were mostly on the front of the body and Kane's about the back. The position of their injuries supports the foregoing reconstruction of events at the time the explosion took place. As the doors were in good working order prior to the explosion, it is probable that No. 2 door had not been properly secured after firing. Had it been secured the two men would not have sustained such severe injuries.

An internal examination of the boiler was subsequently made. There was a considerable amount of soft scale on the water side of the fire row of tubes connecting the steam drum to water drum B. This varied in thickness, there being more deposit on the tubes at the after end of the row. The deposit was not uniformly thick over the internal surface of the tubes, being much thicker on the side of the tubes nearest the fire. At the back end of the fire row the thickness averaged $\frac{1}{8}$ inch, which gradually decreased to 1/16th inch at the front end of the same row. Attached to this deposit were pieces of scale which appeared to have been loosened from the heating surface at some previous time and to have become attached to the scale which subsequently formed on the tubes. Row 2 in the same bank of tubes had only a very slight deposit of scale, while rows 3, 4 and 5 were clean. The two fire rows form the most effective part of the heating surface in the boiler, and the heaviest deposit might be expected here, but as the deposit was thickest at the back end of the fire row, further inquiry was made. It appears that in order to keep the fire of even thickness, more coal had to be put on the back end of the furnace, and consequently evaporation, and therefore scale deposit would be greater at the back end. It follows that risk of overheating would be greater at that end of the first row. This was borne out by the quantity of deposit inside the tubes and by their external appearance.

The banks of tubes connecting water drums A and C to the steam drum were free from any deposit apart from the preservative which had been used at the commencement of the season.

With regard to the tube which ruptured, most of the deposit on this was removed by the rush of water and steam, but there was a small amount left at the parts remote from the rupture. This tube was enlarged over a length of 2 feet 6 ins., which length was in the zone of the flame and gases on their way to the uptake. The tube was measured at intervals of 3 inches over a portion of the length, and the measurements are tabulated on the plate. Sections showing the thickness of the tube at each end of the fracture are given. These sections show that the tube had increased in diameter and that the consequent thinning of the tube wall had taken place at the side exposed to the furnace, *i.e.*, where the scale was thickest. In cases of tubes which burst due to over-heating, the fracture is generally drawn away to a fine edge whereas in this case the fracture was short and the material although below the original thickness, was not drawn out. Ordinary cases of overheating also take the form of a local bulge, whereas in this case the tube had enlarged over a considerable length.

Where overheating and ultimate rupture is caused by deposition of scale, such overheating must occur more than once as when a tube overheats the first time expansion and consequent thinning take place. This expansion throws off the scale, thus allowing water to get in contact with the tube and cool it. Further overheating will not occur until a sufficient thickness of scale again forms. In this case the tube had expanded over a considerable length and this expansion must have taken place previously in one or more stages. Subsequent local overheating due to an excessive accumulation of scale at this point caused the tube to bulge and finally fracture. That the overheating had taken place on more than one occasion is indicated by the portions of thick scale which were found to adhere to scale which had formed at a later period. It has been previously stated that the back end of the boiler had to be more heavily fired than the front end in order to maintain an even thickness of fire. Should the fire become thin, the flame at this part would be intensely hot with result that there would be localised overheating. This, coupled with the presence of scale in the tubes, would account for the thinning of the tube. That the temperature of the material of the tube was at least 1,000 degrees Centigrade was shown by a micro section taken from the fractured edge. This showed a structure associated with quenching from high temperatures. At such temperatures the tenacity and elasticity of the material would be so reduced that the tube could not withstand the pressure and therefore fractured.

The row of tubes nearest the fire in water drum B is being renewed. Steps are also being taken to supply the boilers with pure distilled water only and the use of lime is to be discontinued.

Observations of Mr. A. E. Laslett, Engineer Surveyor-in-Chief.

Cylindrical multitubular boilers working at moderate presures have been almost exclusively used in Merchant Steamships, but in recent years conditions have changed so that it has become necessary to provide for the generation of highly superheated steam at greatly increased pressures. A number of new steamships have, therefore, been fitted with high pressure water tube boilers, and this type of boiler may in future be more largely used in Merchant Ships.

In any type of boiler it is essential that, to avoid corrosion and fouling of the heating surfaces by scale, the feed water should be pure. In seagoing steamships, if there were no loss of feed water by leakage, the question of scale would present little difficulty. Unfortunately there are always losses, and in the present case water obtained from town mains was used to supplement the feed from the condensers. The water was presumably of good quality but hard, and no other treatment was considered necessary than the mixing of lime with the feed water. With boilers of the ordinary marine or Scotch type no exception could reasonably be taken to the methods used in dealing with the feed water, as in such boilers a proportion of the soluble matter in the feed water would probably have been precipitated to the comparatively quiescent water at the bottom of the boiler, and any scale formed would have been distributed more or less uniformly over the heating surfaces. In a water-tube boiler, especially in one of a small tube type, the water is in continual and rapid movement so that there is less chance of solid matter being deposited as sludge; also owing to the heavy evaporation in the tubes near the fire, a large proportion of the scale is formed in those tubes, and even when the feed water is, when judged by old standards, comparatively pure, a thick layer of scale may be rapidly formed, causing overheating and distortion. It is clear, therefore, that only distilled water should be used in high pressure water tube boilers, and in this vessel an evaporator was fitted, so that the desirable degree of purity could have been obtained by distillation of the town water. Such boilers should not be closed up after cleaning before it has been ascertained by inspection that every tube is clear and perfectly clean.

Unfortunately in this case the tube failed while a fire door was open and two firemen were directly exposed to the explosion. The engineers acted with promptitude and apparently did all that was possible in difficult circumstances.

The owners are now arranging for the use of distilled water only for feed make-up.

The following are the Questions set for Candidates who sat for The Student-Graduate Examination, 1928:—

THEORETICAL MECHANICS.

Tuesday, April 17th, 1928. 10 a.m. to 1 p.m.

Answer not more than six questions.

1. Define the following terms: Velocity, Acceleration, Momentum, Work and Energy.

2. A body falls from a height of 1,500 feet. In what time will it reach the ground, and with what velocity will it strike the ground?

3. A train starting from rest gets up a speed of 30 m.p.h. in $1\frac{1}{2}$ minutes. What has been the acceleration, and what distance has it travelled during that time?

4. Define the principle of moments and apply it to the following question: A length of shafting 28 feet long is slung out of the centre. If it requires 500 lbs. hanging at the short end to keep it horizontal, how far out of the centre is it slung?

5. In a wheel and axle the diameter of the barrel is 6 ins. and the rope $1\frac{1}{2}$ ins. If a force of 60 lbs. is applied to the rim of the wheel, which is 30 ins. in diameter, what weight can be lifted if 15% is lost in friction?

6. A double acting pump is employed to pump 1,200 gallons of sea water to a height of 30 feet in 10 minutes. If the efficiency of the pump is ·75, what is the horse-power exerted?

7. If it takes $1\frac{1}{2}$ tons to pull a weight of 8 tons up an incline and $\frac{1}{2}$ ton to pull it down, resistance remaining constant, find the inclination of the incline.

8. Define Angular Velocity. How is it measured? If the rim of a fly wheel revolves through 8·8 radians in 1 second, and if the piston speed is 756 feet per minute, find the stroke of the engine.

9. A 40 ton gun fires a projectile of 800 lbs. with a muzzle velocity of 2,000 f.p.s. How far will the gun recoil against a constant resistance of 8 tons?

10. What is meant by the resolution of forces? Two forces of 30 and 50 lbs. weight act at angles of 45° and 60° respectively. Resolving the forces horizontally and vertically, find the magnitude and direction of the resultant.

HEAT AND HEAT ENGINES.

Tuesday, April 17th, 1928. 2 p.m. to 5 p.m.

Answer not more than three questions from each section of the paper.

All pressures are absolute.

Heat.

1. Two bars, one brass and the other wrought iron, are riveted together at one end. When placed in melting ice, their lengths are the same; viz., 30 ins. On heating the bars to 100° C. the brass bar was observed to be 0·0216 in. longer than the wrought iron bar. Determine the coefficient of linear expansion of brass if for wrought iron the value is 0·0000117.

Give some examples in engineering construction where provision is made for expansion and contraction.

2. Describe with suitable sketches the apparatus you would use to determine experimentally the mechanical equivalent of heat.

3. Define Specific Heat:

A lump of copper (specific heat 0·092) weighing 5 lbs. is heated in a furnace and allowed to drop into 20 lbs. of water at 15° C. If the temperature of the water rises to 41° C. determine the temperature of the furnace. State the objections to this method of measuring high temperatures.

4. Write down the "characteristic equation for a perfect gas," defining the symbols you use.

A torpedo air service reservoir of capacity 12·4 cu. ft. contains air at 2,500 lbs. per sq. in. and at a temperature 15° C. (59° F.). Air is withdrawn from the reservoir until the pressure is reduced to 250 lbs. per sq. in. while the temperature remains constant. Determine the weight of air withdrawn if R, the gas constant for air, is 96·0 ft. lbs. per lb. per ° C. (53·2 ft. lbs. per lb. per ° F.).

5. Explain carefully how the heat of combustion of the fuel in a boiler furnace is transmitted to the water in the boiler. Draw a diagram showing approximately the fall in temperature from the furnace to the water.

Heat Engines.

6. Describe with neatly drawn sketches either—

(a) a compound impulse steam turbine, or

(b) a surface condenser, or

(c) any type of water tube boiler.

7. Explain how you would carry out a test on any type of heat engine to determine the consumption of working substance per I.H.P./hr. and per B.H.P./hr. Give a list of the essential readings that must be taken and the method of making the calculations therefrom.

8. Calculate the cylinder diameter and stroke of a double-acting steam engine that will develop 120 I.H.P. under the following conditions:

Initial pressure 80 lbs. per sq. in., back pressure 16 lbs. per sq. in., R.P.M. 100, average piston speed 500 ft./min. Cut off at half stroke. Neglect clearance and assume the expansion is hyperbolic. Take the diagram factor as 0·85.

9. Describe the cycle of operations of an internal combustion engine working on the Otto cycle. What are the principal differences between the Otto and the Diesel cycles of operations. Draw to scale an average indicator diagram for the latter cycle.

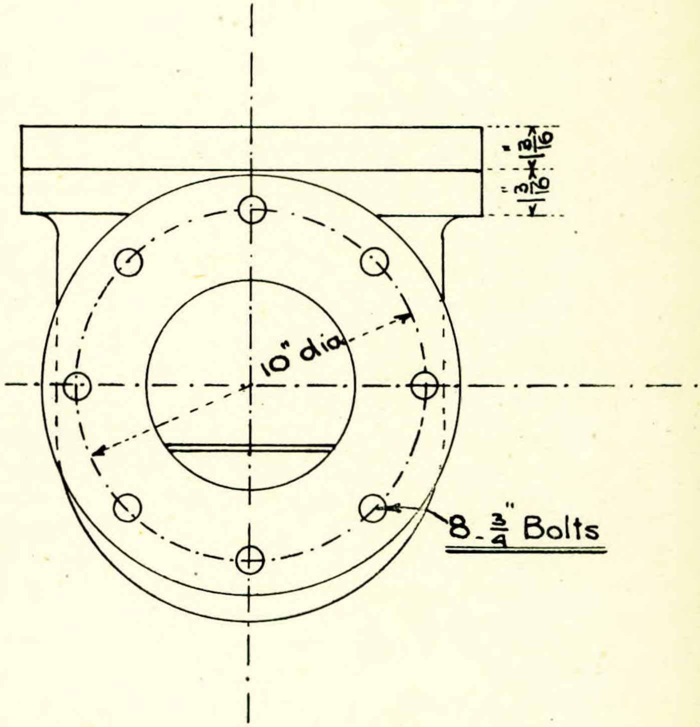
10. An oil fired boiler generates steam which is 96% dry at a pressure of 180 lbs. per sq. in. from feed water at a temperature of 79·5° F. If 11·8 lbs. of steam are generated per lb. of oil and the calorific value of the oil is 19,000 B.Th.U. per lb., determine (a) the thermal efficiency of the boiler (b) the equivalent evaporation from and at 212° F.

Sensible heat 79·5° F. = 47·4 B.Th.U./lb.

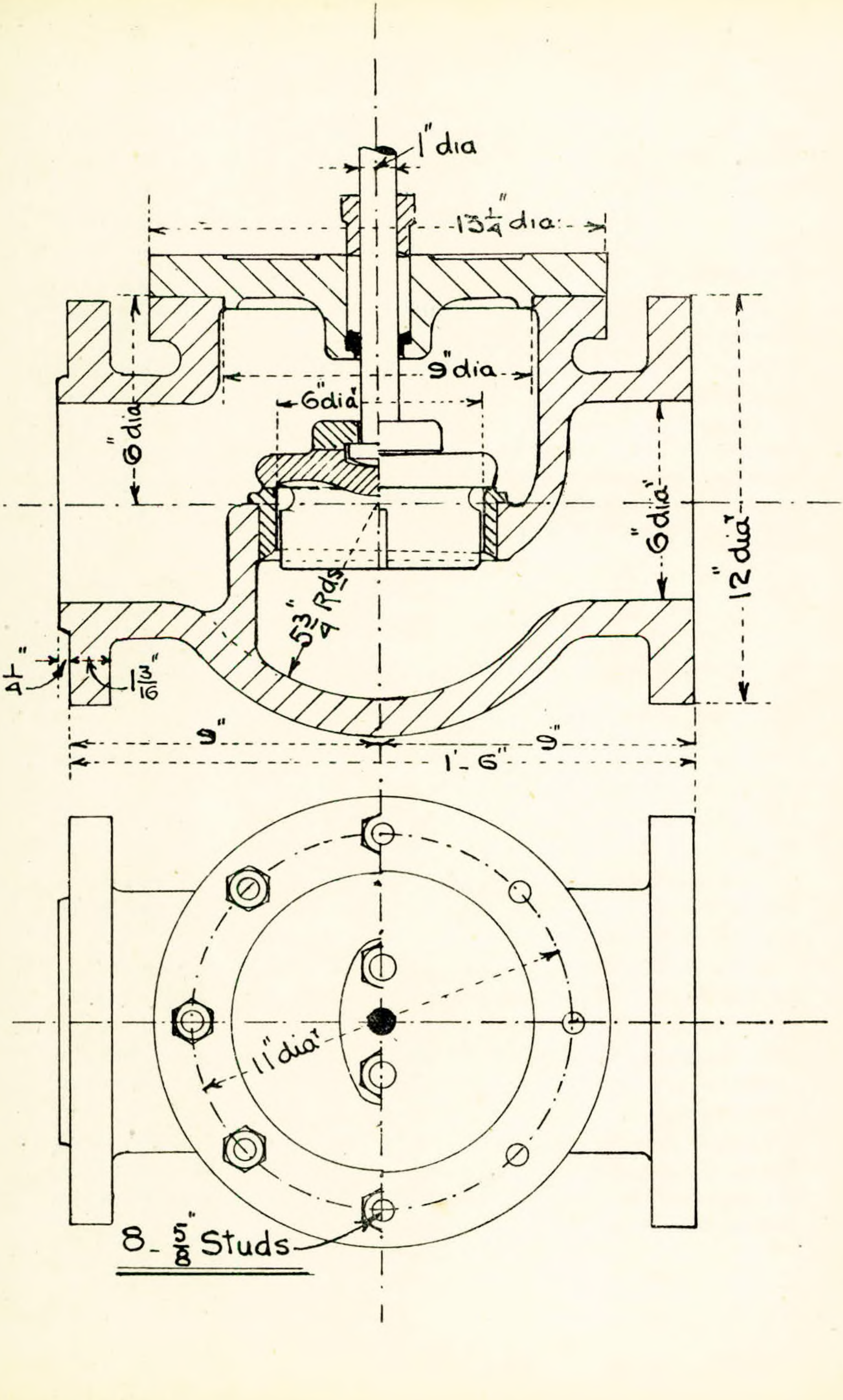
Sensible heat at 180 lbs. per sq. in. = 346·1 B.Th.U./lb.

Latent heat at 180 lbs. per sq. in. = 857·3.

Latent heat at 212° F. = 970·7 B.Th.U./lb.


10" dia
8 - $\frac{3}{4}$" Bolts
$\frac{13}{16}$
$\frac{13}{16}$

TO ACCOMPANY QUESTION 1.



MACHINE CONSTRUCTION AND DRAWING.

Wednesday, April 18th, 1928. 10 a.m. to 1 p.m.

1. The drawing supplied gives some particulars of a 6 in. Stop Valve and you are required to make separate drawings of (a) the Body, (b) the Cover, and (c) the Valve Seat.

The drawings must give all the figures and particulars required to make the patterns and to machine the parts ready for assembly.

2. What lift should you allow this valve, and how do you determine this figure?

Note.—The drawings must not be inked in, and no credit will be given for doing so. Credit will be given for the proper use of projection. A clear workmanlike drawing to scale, one-quarter full size (3 inches = 1 foot) completely dimensioned, with all the instructions required for properly finishing the work in the shops without any reference to the drawing office, will alone gain full marks.

APPLIED MECHANICS.

Wednesday, April 18th, 1928. 2 p.m. to 5 p.m.

Answer not more than six questions.

1. In the testing of materials, what is meant by the following terms: Stress, Strain, Elasticity, and Yield Point?

2. If a steel wire $\frac{1}{4}$ in. diameter is stretched 1/50th of its length by a weight of 15 tons, find the modulus of elasticity.

3. A steel wedge whose taper is $\frac{1}{2}$ in. per foot of length, is employed to raise a weight of 2 tons $\frac{3}{4}$ in. Find the force applied to the head of the wedge.

4. In a differential pulley block, the ratio of the sheaves is as 1 is to ·9. What force is necessary to raise half a ton, neglecting friction.

5. Applying the law of the parallelogram of forces, find the pressure per sq. in. on the piston under the following conditions:

Length of connecting rod 9 ft. 4 ins., stroke of engine 4 ft. When the crank was at right angles to the centre line of motion the pressure on the guide was 10,800 lbs. The diameter of the piston was 30 ins.

6. Two men are employed to roll a cask of oil weighing 5 cwts. up a gangway inclined to the quay at an angle of 30°, by means of ropes passed round it. Find the pull each man exerts.

7. A wrought iron plate is in the form of an isosceles triangle, whose sides are 12 feet and base 8 feet. Find its weight at 480 lbs. per cubic foot, also the position of the centre of gravity.

8. If, in the above plate, a hole 4 ft. in diameter is cut, whose centre is 3 ft. up from the base, find the position of the new centre of gravity.

9. How does the strength of rectangular beams vary? Compare the strength of two beams A and B where subject to the same bending moment.

A—Breadth $3\frac{1}{2}$ ins.: Depth 8 ins.

B—Breadth 4 ins.: Depth 7 ins.

10. A weight of 8 lbs. is revolving in a vertical circle of 4ft. radius. Find the minimum revs. per min. at which it will run to maintain itself in the circle.

MATHEMATICS.

Thursday, April 19th, 1928. 10 a.m. to 1 p.m.

Eight questions only to be attempted. Not more than three may be selected from any section; candidates cannot pass unless marks are obtained in each section.

Arithmetic.

1.—(*a*) Find the least common multiple of $2\frac{1}{2}$, $6\frac{1}{8}$ and 5 and (*b*) reduce to their least common denominator $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$ and $\frac{1}{7}$.

2.—(*a*) Which is the greater, $\frac{1}{19}$ of £1, or $\frac{1}{20}$ of a guinea? and (*b*) which is the greater $\sqrt{\frac{2}{3}}$ or $\sqrt[3]{\frac{2}{3}}$?

3.—Find the value of (*a*) $\dfrac{4\frac{1}{3} \times 4\frac{1}{3} \times 4\frac{1}{3} - 1}{4\frac{1}{3} \times 4\frac{1}{3} - 1}$

(*b*) $1\frac{17}{51} + \frac{8}{3} \text{ of } \frac{4}{34} + \dfrac{4}{5\frac{1}{10}} + 0\cdot6666...$

4.—Find the value of $\dfrac{1}{\sqrt{3}}$ correct to six places of decimals and of $\sqrt{\dfrac{5\cdot04}{0\cdot012}}$ to three places of decimals.

5. A square inch of metal 0·05 inches thick is drawn into wire of uniform diameter 50 feet long: find the diameter of the wire.

6. A silver coin weighs 3 dwts. 15 grains, of which 3 parts out of 40 are alloy, and the remainder pure silver. How much is there of alloy, and what weight is pure silver?

Algebra.

7. Find the factors of

(*a*) $(a + b)^3 + 125c^3$

(*b*) $a^2 - 10ab + 25b^2 - c^2 + 12cd - 36d^2$

(*c*) $(x + y)^2 + 11(x + y) + 30$.

8. Find the least common multiple of

$4(a^2 + ax)$; $12(ax^2 - x^3)$; $18(a^2 - x^2)$

and the greatest common multiple of

$4(a^3 - ab^2)$ and $6b(a^3 + b^3)$.

9. At what times are the hands of a clock over each other between 9 and 10 o'clock?

10. Solve two of the following equations:

(*a*) $$\frac{\sqrt{x} - 1}{\sqrt{x} + 1} = \frac{4}{x - 1}$$

(*b*) $$x + y = 2$$
$$x^2 + xy = 18$$

(*c*) $$\frac{5\sqrt{x + y}}{x} + \frac{5\sqrt{x + y}}{y} = 10\tfrac{2}{3}$$

(*d*) $$\frac{3\sqrt{x - y}}{y} - \frac{3\sqrt{x - y}}{x} = \frac{4}{5}$$

11. Find the value of

$$\left(\frac{x}{x - 1}\right)^2 + \left(\frac{x}{x + 1}\right)^2 \text{ when } x = \sqrt{\frac{n - 1}{n + 1}}$$

12. A gardener without arithmetical knowledge planted some trees in the form of a square. His first attempt resulted in a square, but he had 11 trees to spare; he then added one more to each row, and found that he wanted 24 more trees to complete the square. How many trees had he to plant?

13. Solve the equations:

(a) $$\frac{1}{x^2} - \frac{2}{3x^2 + 1} = \frac{5}{4(3x^2 + 1)}$$

(b) $$\frac{1 + x + x^2}{1 - x + x^2} = \frac{62}{63} \times \frac{1 + x}{1 - x}$$

Geometry.

14. Show how to divide a finite straight line AB into five equal parts. Prove the truth of your construction.

15. Having given a straight line AB as the unit of length, show how to find lines representing by their lengths, the values $\sqrt{2}$, $\sqrt{3}$, $\sqrt{4}$, and $\sqrt{5}$. Prove the truth of your methods.

16. If from any point A in the diameter of a circle, or its extension, lines be drawn to the ends B and C of a parallel chord, show that the squares on those lines AB and AC are together equal in area to the squares on the segments into which the point A divides the diameter.

17. If a chord AB of a circle be produced to C so that the produced part BC is equal to the radius of the circle, and a line drawn from the extremity C of the produced part to pass through the centre F of the circle to meet the concave part of the circumference E, show that the concave part of the circumference AE intercepted is equal to three times the convex intercept BD.

18. If the rectangles under the segments AE.EC and BE.ED made by the intersection of the diagonals of a quadrilateral figure ABCD are equal in area, or if the rectangles under the segments EA.ED and EB.EC made by producing opposite sides AD,BC to intersect E are equal in area, then the quadrilateral may have a circle described about it.

19. Show that the external angles of any rectilinear figure are together equal to four right angles. Also that all the internal angles of any rectilinear figure, together with four right angles, are equal to twice as many right angles as the figure has sides.

DICTATION.

April 19th, 1928. 2 to 2.15 p.m.

15 minutes allowed.

It was the tragedy of Babylonia, first, that not all its hot-house fertility lay within the embrace of the two rivers; second, that the Tigris, unlike the Euphrates, passes through the foot-hill region so obliquely and gradually, and receives such large side-streams in this part of its course, that it can support a considerable population, at a distance far enough removed from

Babylonia to be beyond its permanent control, and yet near enough to it to feel its spell, and to become a standing menace to it. The first cause brought a great power into existence in Elam; the second permitted the rise of Assyria to independence, rivalry, and then to empire. Both brought a variety and a turmoil into the long history of Babylonia, which contrast very markedly with the habitual seclusion of Egypt.

ENGLISH LANGUAGE, including COMPOSITION.

Thursday, April 19th, 1928. 2 p.m. to 5 p.m.

All candidates must do Question (1), Dictation.

Of the remaining questions only five must be attempted.

1. Passage to be read for Dictation. Time allowed 15 minutes.

2. Give a general grammatical analysis of the following:— "Had I known what was in store for me in London, where, for the next two long years, I struggled to earn in the pursuit of literature the comforts that every other employment I had tried had failed to provide me, I should certainly have taken the advice that was so frequently given me by my friends."

3. Parse fully the verbs, "had known," "to earn," "to provide," "should have taken."

4. Name the authors of: "Tales of a Grandfather," "The Lord of the Isles," "The Vision of Mirza," "Lady Clare," "Boadicea," "Robinson Crusoe," "Essay on Man," "The Cottar's Saturday Night," "Gulliver's Travels," "Comus," "Childe Harold's Pilgrimage," "The Deserted Village," "The Seasons," "Oliver Twist," "Sir Roger de Coverley."

5. Write a summary of a play which you have seen or read.

6. Define and give examples of the following figures of speech: Simile, Metaphor, Personification, Allegory, Synecdoche, Metonymy and Hyperbole.

7. Correct the following: "Who was you with?" "I and he was there." "Neither you nor I are needed." "Who is their? Me." "Every man stood still and held their breath." "These are the master's rules, who must be obeyed." "They attacked the Duke of Northumberland's house, whom they put

to death." "We do these things frequently which we repent of afterwards." "A variety of pleasing objects charm the eye."

8. Discuss the excellences and defects of your favourite newspaper or magazine.

9. In what various ways did Latin contribute to the English Language?

10. Write out fully all the tenses and moods, of the verb "to do," in the active and passive voices.

ELECTRICAL ENGINEERING.

Friday, April 20th, 1928. 10 a.m. to 1 p.m.

Eight questions only to be answered.

1. State the several phenomena which indicate that a current is flowing in a conductor or wire. On what grounds are we justified in saying that the current flows in one direction or another?

2. Upon what does the heating effect of a current depend? How would you prove one of your statements? No. 20 Gauge Nickel-Chrome wire has a resistance of 1360 ohms per 1000 yards. What length of wire would be needed for an electric heater taking 200 watts at 110 volts?

3. A D.C. motor under test gave the following results: P.D. 460 volts, current 33 amps., effective load on brake 210 lbs., diameter of brake pulley 13 ins., R.P.M. 785. Find the B.H.P. and efficiency.

What precautions to secure accuracy would you take in making such a test?

4. A solenoid 20·5 cms. long is wound on a brass former and has an internal depth of 2·5 cms. It is wound with 2,500 turns of wire and carries one ampère. Find (1) the magnetising force and (2) the flux at the centre of the coil.

5. Describe any moving coil ammeter with which you are acquainted. What advantages has this type over soft iron instruments?

6. Describe with a neat sketch some form of Standard Cell.

7. How would you measure the resistance of a wire by using an ammeter and voltmeter without using any auxiliary resistance? Give a sketch of the connections you would make.

8. Write short notes of the following materials, giving their uses in electrical engineering: porcelain, mica, ebonite, vulcanized fibre, aluminium and slate.

9. What is a relay and what are its uses?

10. How would you measure the candle power of an incandescent lamp?

11. An installation consists of 150 30 watt lamps.
100 60 watt lamps.
4 250 watt heaters.
5 10 H.P. Motors.

What will it cost to run the above installation for 20 hrs. at 2d. per unit?

12. Sketch neatly (*a*) a Brush Holder or (*b*) a Commutator of a D.C. Dynamo.

13. Find the resistance of 1 mile of 19/18 cable. The diameter of No. 18 copper wire is 0·048 inches and the resistance of an inch cube of copper between opposite faces is 0·66 microhm.

14. Find the flux per pole of a 6 Pole D.C. Generator having 180 conductors in series to give 110 volts at 375 R.P.M. Deduce the formula you use.

The following are questions which were set for candidates who sat for The Lloyd's Register Scholarship Examination, 1928:—

ARITHMETIC AND ALGEBRA.

Monday, May 7th, 1928. 10 to 11.30 a.m.

Only three questions to be attempted in each section: six questions in all.

Arithmetic.

1. Reduce to lowest terms:

$$\frac{5184}{6912}; \qquad \frac{7631}{26415}; \qquad \frac{236432}{2347432}$$

2. What is the value of $\frac{3}{14}$ of half a guinea? and what fraction of half-a-crown is $\frac{3}{5}$ of 6s./8d.

3. Divide $\frac{1}{2} + \frac{1}{4} + \frac{1}{6} + \frac{1}{8} + \frac{1}{10}$ by $\frac{1}{3} + \frac{1}{5} + \frac{1}{9} + \frac{1}{15}$. Express the result as vulgar and decimal fractions.

4. Find the square roots of 21609 and 915849.

5. Find the cube root of 1030301.

6. A tank is filled by means of two pipes; one alone can fill the tank in 40 minutes, the second in 30 minutes, whilst it is emptied by a pipe in 35 minutes. If the tank is empty and all three pipes are opened, find the time taken to fill the tank.

Algebra.

7. Reduce to its lowest terms:

$$\frac{2a^2 - 3a + 1}{a^2 + a - 2} \text{ and } \frac{9x^2 - 12xy + 4y^2}{6x - 4y}$$

8. Find the square roots of:

(*a*) $$\frac{9}{16} - \frac{7}{6}a + \frac{49}{81}a^2$$

(*b*) $$3 + \frac{a^4 + b^4 + 2ab^3 + 2a^3b}{a^2b^2}$$

9. Find the value of x in:

(*a*) $$\sqrt{x} + \sqrt{4 + x} = \frac{2}{\sqrt{x}}$$

(*b*) $$\frac{13-2\sqrt{x-5}}{13+2\sqrt{x-5}} = \frac{3}{23}$$

10. Solve the equations:

(*a*) $$\frac{3}{1 + x} + \frac{3}{1 - x} = 8$$

(*b*) $$x^2 - \frac{3x}{2} = 27$$

11. A certain fraction becomes equal to $\frac{1}{2}$ when both numerator and denominator are diminished by 1, but if 2 be taken from the numerator and added to the denominator, it becomes equal to $\frac{1}{3}$: what is the fraction?

12. A man and a boy engaged to do some work for 21/-, but when $\frac{2}{5}$ was done, the boy went away, and the man finished it alone. The work occupied $1\frac{1}{4}$ days more than it should have done. The boy could only do half a man's work, and was paid in proportion. What did each receive per day?

HYDROSTATICS AND THERMODYNAMICS.

Monday, May 7th, 1928. 11.30 a.m. to 1.0 p.m.

Answer not more than three questions from each section of the paper.

Hydrostatics.

1. A settling tank is 4 ft. x 5ft. x 3 ft. deep and contains equal quantities of oil and water to a depth of 2·5 ft. If the specific gravity of the oil is 0·92, determine the presses on the sides and bottom of the tank. (Take the weight of 1 cu. ft. of water as 62·4 lb.)

2. Describe briefly two methods you would employ to determine the specific gravity of a piece of wood of 1 inch cube.

3. A uniform tube 6 ft. in length, closed at one end, is half filled with mercury. The open end is then closed with the finger and the tube inverted with this end just dipping in a trough of mercury. What will be the height of the mercury in the tube when the finger is removed? Take the height of the barometer as 30 in. of mercury.

4. Describe any type of hydrometer and explain its use.

5. A hydraulic accumulator ram is 9 ins. diameter and 12 ft. long. It is supplied with water by a single-acting pump making 40 r.p.m. The stroke is four times the pump plunger diameter. If the pump supplies sufficient water in 10 minutes to lift the accumulator ram through its length, what is the diameter of the plunger?

Determine the load on the ram if the water pressure is to be 700 lb. per sq. in. and also the approximate H.P. required to drive the pump.

Thermodynamics.

All pressures are absolute.

6. A petrol engine of cylinder diameter 3·5 in. and 4 in. stroke, makes 1,200 r.p.m. The mean indicator diagram has an area 1·52 sq. in. and length 3 in.; the scale of the indicator spring is 200 lb. per sq. in. to 1 in. Estimate the I.H.P. of the engine.

7. If the specific heats of air at constant volume and constant pressure are 0·169 and 0·238 respectively, and Joule's equivalent 1,400 ft. lb. = 1 C.H.U., determine (*a*) the gas constant for air and (*b*) the weight of 20 cu. ft. of air at a pressure of 400 lb. per sq. in. and temperature 20° C.

8. Distinguish between an isothermal and an adiabatic process. Twelve cubic feet of gas at 14·7 lb. per sq. in. are compressed until the pressure reaches 85 lb. per sq. in. If the cylinder is surrounded by a water jacket, calculate the heat transferred to the water if the temperature of the gas is to be kept constant during compression.

9. Describe carefully the process of converting water into superheated steam at constant pressure.

10. The velocity of the steam leaving the nozzle in a simple impulse turbine of the De Laval type is 3,000 ft. per sec. and the nozzle is set at an angle of 20° to the plans of rotation of the wheel. If the wheel runs at 15,000 r.p.m. and the mean diameter of the blade ring circle is 2 ft., find the blade inlet angle if there is to be no shock at entry.

GEOMETRY.

Monday, May 7th, 1928. 2 to 3.30 p.m.

Only six questions may be attempted, three from each section.

A.

1. Draw a line AB. If AB is x inches long, draw a line of length x^2 inches. Show that your construction leads to a correct result.

2. Draw a triangle whose sides are 5, 6 and 7 cms. long respectively, and construct a square of equal area. Check your result by the formula $\sqrt{s(s-a)(s-b)(s-c)}$ where a, b and c are the sides of the triangle, and $s = \frac{1}{2}(a + b + c)$.

3. OA, OB are two lines such that OA = 6 cms. The angle AOB = 40°. Draw the circle touching OA at A, and intercepting on OB, a length equal to 5 cm.

4. Solve graphically the equation $x - y = 5$ and $xy = 16$. Check your answer, and state the geometrical truths underlying your solution.

5. Draw two lines which meet at a point off your paper, and construct the line bisecting the angle between them.

B.

6. If AD is the altitude of a triangle ABC, the angle BAC being a right angle, prove that (*a*) the square on AD is equal

to the rectangle BD.DC, also (*b*) the square on BA is equal to the rectangle BD.BC.

7. If two chords of a circle (produced if necessary) cut one another, the rectangle contained by the segments of one is equal to the rectangle contained by the segments of the other.

8. If the vertical angle of a triangle is bisected internally or externally by a straight line which cuts the base, or the base produced, prove that it divides the base internally or externally in the ratio of the other sides of the triangle.

9. Take any point C in any line AB, and CD such that the angle BCD is an acute angle. Take any point P within the angle ACD and from P draw a line cutting CD in Q and CB in R, such that QR is twice as long as PQ.

10. Show how to inscribe a circle in a regular pentagon, and prove the truth of the construction.

Prove that the middle points of the sides of a regular polygon are the vertices of another regular polygon.

GENERAL KNOWLEDGE AND ENGLISH COMPOSITION.

Monday, May 7th, 1928. 3.30 to 5.0 p.m.

Candidates must not attempt more than six questions.

1. Give a general grammatical analysis of the following passage, showing the relation of the clauses to each other:

" As a growling wolf,
Whom hunger drives to seek new haunt for prey,
Watching, where shepherds pen their flocks at eve
In hurdled cotes amid the field secure,
Leaps o'er the fence with ease into the field;
Or, as a thief, bent to unhoard the cash
Of some rich burgher, whose substantial doors
Crossbarred and bolted fast, fear no assault,
In at the window climbs, or o'er the tiles;
So clomb this first grand thief into God's fold."

2. Parse fully the words underlined in the above passage.

3. State the various ways of forming the Plural from the Singular of Nouns. Give examples.

4. Describe a day's work done by yourself.

5. Give a short description of the great deserts of Asia and Africa.

6. State what you know of the Solar System.

7. Quote twelve lines from a poem. Name the author and title of the poem.

8. What is Parliament? How is it elected, and who are the electors? Define and illustrate the parliamentary terms: adjournment, prorogation and dissolution.

9. Name the authors of the following works: "Paradise Lost," "The Faery Queen," "Vanity Fair," "Robinson Crusoe," "The Task," "Kenilworth," "The Excursion," "The Idylls of the King," "Peter Pan," "Treasure Island," "The Pilgrim's Progress," "Westward Ho," "Huckleberry Finn," "Endymion," "The Cloud," "The Ancient Mariner."

10. Write a short essay on:

> "To thine own self be true,
> And it must follow, as the night the day,
> Thou canst not then be false to any man."

APPLIED MECHANICS.

Tuesday, May 8th, 1928. 10 to 11.30 a.m.

Answer not more than six questions.

1. Enunciate the parallelogram of forces. Two equal forces act at a point firstly at an agle of 45°, secondly at an angle of 60°. Compare their resultants.

2. A derrick 30 ft. long is connected by a tie-rod to a post making a right angle with the post. If the tie rod is 10 ft. long, and a weight of 3 tons is hanging from the top of the derrick; find the stress in the derrick, also in the tie rod, and name the forces.

3. What do you mean by the principle of moments? Apply the law in solving the following question: a length of shafting 16 feet long, and weighing 1 ton is slung out of the centre. A weight of 240 lbs. is hung at the shorter end to maintain it horizontal. How far from the centre is it slung?

4. A pair of rope blocks having three sheaves at each end is employed to lift a weight of 480 lbs. Find the pull on the free end, neglecting the friction of the sheaves and the weight of the bottom block.

A man weighing 12 stones lifts himself with the weight. Find the difference in the pull.

5. Define Velocity, Acceleration, Momentum, Work, and Energy, distinguishing between potential and kinetic energy. A body falls from the height of 1,200 feet; with what velocity will it reach the ground, and in what time?

6. If in the previous question a body is projected upwards at the same instant with a velocity of 200 ft. per sec., at what height from the ground will they meet?

7. What do you mean by the efficiency of a machine? Analyse the expression: "Energy expended = work done."

A screw jack is employed to lift a weight of 3 tons; if the pitch of the screw is $\frac{1}{4}$ in., and the length of the toggle bar 2 feet, find the force at the end of the toggle bar (1) neglecting friction, (2) taking the efficiency at ·7, what amount of work is lost in overcoming the friction?

8. If it takes the force of 1 ton to pull a weight of 8 tons up an incline, and 4 cwts. to pull it down (friction remaining constant), what is the inclination of the plane?

9. A steam hammer whose weight is 1 ton, falls freely through 5 ft. and compresses a red hot bloom $\frac{3}{4}$ in. Find the mean force of compression.

If the diameter of piston is 12 ins. and steam at 90 lbs. per sq. in. (gauge) is applied during the down stroke, what is now the compression stress?

10. A vessel of 8,000 tons displacement steaming at 15 knots is suddenly stopped to avoid a collision. If the mean resistance is 100,000 lbs., how far will she go before coming to rest? (1 knot = 6,080 feet per hour). Take g = 32 f.s.s.

FRENCH.

Tuesday, May 8th, 1928. 11.30 a.m. to 1.0 p.m.

Candidates must not answer more than six questions, which must include No. 2 (translation—English into French).

1. Translate into English:

"Un derviche, voyageant en Perse, arrive à la capitale et dans l'idée que les grands du pays épuisent souvent leurs trésors pour bâtir et fonder des caravansérais, il prend le palais du roi pour une de ces magnifiques auberges. D'un esprit distrait il en traverse la première et la seconde cour, monte les galeries, y pose sa valise et s'en fait une chevet. Un des gardes l'apercoit, l'instruit du lieu qu'il profane et vent a l'instant l'en chasser. Pendant le débat le monarque passe, sourit de la méprise du voyageur, et lui demande comment il puet prendre la demeure d'un souverain pour une hôtellerie."

2. Translate into French:

"Sire," said the dervish humbly, "dare I put a question to you? Who were the masters of those beautiful places before Your Majesty?" "My father, my grandfather and all my ancestors one after another," answered the King to him. "And after you," added the dervish "to whom are these great possessions destined?" "Doubtless to the prince, my son," exclaimed the astonished monarch. "Ah, sire," replied the pilgrim, "a house which changes its host so often, has the fine name of 'palace,' but it is indeed only a real caravansérai."

3. Give the feminine of: vieux, sot, frais, vif, distrait, vrai, doux, épais, sec, ancien, vengeur, accusateur, majeur, serviteur, sculpteur, malin, traitre.

4. Give the odd cardinal numbers and the even ordinal numbers up to twenty in French.

5. Express in idiomatic French:

(a) These men, women and children are playing.

(b) Give him this book and that slate.

(c) What pleases me is his modesty.

(d) Of all the virtues that which makes itself most beloved is humanity.

6. Write out fully all the simple tenses of Avoir.

7. Write out the Preterite Tense of: parler, finir, vendre and recevoir.

8. Write out fully the verb: Aller.

9. Correct mistakes (if any), giving your reasons, in:

(a) Pensez-vous il viendra? (b) Je ne vois pas personne. (c) Je m'ai enfaire un habit neuf. (d) Je ne sais pas votre amie. (e) Ni l'or ni la grandeur nous rendent heureux. (f) Elle s'est coupée le doigt.

10. Illustrate in several sentences the use of the Subjunctive Mood in French.

PLANE TRIGONOMETRY AND LOGARITHMS.

Tuesday, May 8th, 1928. 2 to 3.30 p.m.

Only six questions may be attempted, four from Plane Trigonometry and two from Logarithms.

Plane Trigonometry.

1. The sides of a right-angled triangle, are in the ratio 5:12:13. Find the sine, cosine and tangent of each of the acute angles.

Also show that $\sin^2 A + \cos^2 A = 1$ is true for any value of A.

2. Show from first principles that $\sin 18^\circ = \dfrac{\sqrt{5} - 1}{4}$

3. What distance in space is travelled in $1\frac{1}{2}$ hours, in consequence of the earth's rotation, by a man situated in latitude 60° N? (Assume the earth to be a sphere of 4,000 miles radius).

4. Explain by means of diagrams, the full algebraical solution of the equation $\cos\theta = a$.

5. Solve the equations:

(a) $5\tan^2 x - \sec^2 x = 11$
(b) $5\tan^2 x + \sec^2 x = 7$

6. Prove that

(a) $\sin(A + B) = \sin A \cos B + \cos A \sin B$
(b) $\sin(A - B) = \sin A \cos B - \cos A \sin B$

7. If $\tan A = \frac{5}{6}$ and $\tan B = \frac{1}{11}$, prove that $\tan(A + B) = 1$. What is $(A + B)$ in this case?

8. A man walking along a straight road at the rate of 3 miles per hour, sees in front of him a balloon at an elevation of 60° travelling in the same direction horizontally at 6 miles per hour. Ten minutes later he notes that the elevation of the balloon is 30°. Find the height of the balloon.

9. Two ships leave harbour together, one sailing N.E. at the rate of $7\frac{1}{2}$ miles per hour, and the other sails N. at 10 miles per hour. Find the distance between the ships at the end of $1\frac{1}{2}$ hours.

10. Show that $\sqrt{\frac{a+b}{a-b}} + \sqrt{\frac{a-b}{a+b}} = \frac{2 \sin A}{\sqrt{\cos 2B}}$

where, as usual, a and b are sides opposite the angles A and B, and C is a right angle.

Logarithms.

11. Define: logarithm, mantissa, and characteristic.

12. What is the logarithm of 32 to the base 2? Also what is the logarithm of $a^{\frac{3}{2}}$ to the base a?

13. Having given that to the base 10

log. 2 = 0·3010300 : log. 3 = 0·4771213 : and
log. 7 = 0·8450980,

find the value of $\sqrt[3]{6} \times \sqrt[4]{7} \times \sqrt[5]{9}$, and the value of $\sqrt[10]{2} \times 3^{-\frac{5}{4}} \times 7^{\frac{7}{11}}$. (The candidate may use his tables for discovering the natural numbers required.)

14. Find the area of a triangle whose sides are 3, 5 and 6 feet respectively. Also the angle opposite the side whose length is 3 ft.

15. Show that for any triangle

$$a = b \cos C + c \cos B$$
$$b = c \cos A + a \cos C$$
$$c = a \cos B + b \cos A$$

PRACTICAL ENGINEERING.

Tuesday, May 8th, 1928. 3.30 to 5 p.m.

Six questions only to be answered.

1. What is Muntz Metal? Where is it used, and why?

2. Sketch an expansion joint for a large steam pipe in which a sharp bend is fitted.

What special precautions are made in this type of expansion joint?

Show a good type of bend which may be fitted to avoid fitting an expansion joint. What care does an expansion joint require?

3. Describe how multitubular marine boilers are fitted to a ship. How are they secured. Make a sketch to illustrate your answer.

4. Describe Stevenson's Link Motion, with the aid of sketches. What do you mean by linking up?

5. Sketch (profile) a Locomotive Boiler, and state how and where you would place the Regulator.

6. How would you fix up a line of shafting on the wall of a workshop?

7. What is an Expansion Valve, and why is it used?

8. Define Lap, Lead, and Cut off. Illustrate your answer with sketches and state how the clearance of a cylinder is measured.

9. How many methods are there of propelling a vessel, and what in your opinion is the most economical, say for an 8,000 ton cargo vessel?

10. Describe a repair job that has come under your personal experience.

11. Describe, with the aid of sketches, how the combustion chambers of a marine boiler are supported? (a) Single ended. (b) Double ended.

12. Make a rough sketch of the midship section of a vessel, showing the method of plating.

GERMAN.

Tuesday, May 8th, 1928. 11.30 a.m. to 1 p.m.

Candidates must not answer more than six questions, which must include No. 2 (translation—English into German).

1. Translate into English:

"Der Schwan wollte einmal ein Gastmahl geben, und alles war dazu vorbereitet, aber sein Diener der Frosch, hatte alle Einladungskarten, bis auf eine, verkehrt abgegeben. Als der Schwan sanft am Ufer des Teiches umher schwamm, und seinen schönen Hals hin und her bog, um nach seinen Gästen auszusehen, da erschienen zu seinem Schrecken, der Kuckuck, die Schwalbe, die Nactigall, die Buchstelze, der Sperling und die Ente. Nur die Ente war erwartet; was sollte er mit den übrigen Gästen anfangen, die für Wasser gar nicht taugten."

2. Translate into German:

The Duck waddled forward, plunged into the water and whispered to the Swan; " Well, Sir Gossip; what have you arranged for your guests? What should they do on the water? " " My dear," replied the Swan, " I say with you, what should they do on the water? I think, that knave the Frog has lost his senses; but at present, let's cheerfully to land, there's nothing else to be done, for these respected ladies and gentlemen will drown if we go not to them."

3. Decline in all cases, Singular and Plural, the Personal Pronouns: ich, du, er, sie, es.

4. Write out fully the Present, Imperfect, Perfect and Pluperfect Tenses of the Indicative Mood of " Reden."

5. Give the principal parts (Indic. Pres. and Imperfect, Imperative and Past Participle) of Gleichen, Reiten and Schneiden.

6. Write out fully the Present and Imperfect Indicative of " Haben " and " Sein."

7. Give the equivalent German idioms for the following proverbs:

" Many hands make quick work."
" The more haste the worse speed."
" Like master, like man."

8. Give the German for:

" Whose hat is that? " " To whom do you give this ring? " " Whom has he asked? " " What do you want? " " What is he looking for? " " Of what have you spoken? "

9. Translate into English:

Der Schütze.

Mit dem Pfeil und Bogen
Durch Gebirg und Thal,
Kommt der Schütz gezogen
Früh am Morgenstrahl.

Wie im Reich der Lüfte
König ist der Weih,
Durch Gebirg und Lüfte
Herrscht der Schütze frei.

Ihm gehört das Weite;
Was sein Pfeil erreicht,
Das ist seine Beute,
Was da kreucht und fleugt.

10. Give the cardinal numbers up to 30 in German.

Board of Trade Examinations.

List of Candidates who are reported as having passed examination under the provisions of the Merchant Shipping Acts.

For week ended 14th July, 1928:—

NAME.	GRADE.	PORT OF EXAMINATION.
Rice, George H.	2.C.	Liverpool
Richardson, Leslie W.	2.C.	,,
Bovingdon, Frederick T. ..	1.C.	London
Lawrence, Harold J.	1.C.	,,
Macfarlane, Roderick M. ...	1.C.	,,
Turner, Frank L.	1.C.	,,
Walcroft, Ernest T.	1.C.	,,
McKeand, Alexander J.	2.C.M.	,,
Robins, Charles A.	2.C.	Southampton
Lemmon, George E.	2.C.	,,
Thompson, Philip H.	1.C.M.E.	,,
Ferry, Ernest S.	1.C.M.E.	North Shields
Mason, George W.	1.C.M.E.	,,
Blachford, John	1.C.	,,
Metcalf, Arthur T.	1.C.	,,
Muncaster, Frank	1.C.	,,
Moody, Thomas L.	2.C.	,,
Tinn, James T.	2.C.	,,
Stafford, John	1.C.M.E.	London
Gibbs, Watson	1.C.M.E.	Sunderland
Davies, Arthur S.	1.C.M.E.	Cardiff
Moxon, Wilfred J.	1.C.	,,
George, Wilfred	2.C.	,,
O'Connell, George T.	2.C.	,,
Pullen, Isaac L.	2.C.	,,
Campbell, John R.	1.C.	Glasgow
McLennan, John	1.C.	,,
Davidson, Robert	2.C.	,,
Findlay, Alexander S.	2.C.	,,
Harper, Hugh A.	2.C.	,,
Macartney, James	2.C.	,,
Riach, John G.	2.C.	,,
Smith, Gordon	2.C.	,,
Henderson, George	2.C.M.	,,
Horn, James	2.C.M.	,,
Alexander, James H.	1.C.	Leith
McClymont, John	1.C.	,,
Slater, William B.	1.C.	,,
Bell, Moray W.	2.C.	,,
Slater, Eric R.	2.C.	,,
Whyte, Charles G.	2.C.	,,
Brand, George H.	1.C.	Liverpool
Gair, John B.	1.C.	,,
Bryant, Arnold C.	2.C.	,,
Carr, John S.	2.C.	,,
Corlett, George F.	2.C.	,,
Crellin, John P.	2.C.	,,
North, Joseph E.	2.C.	,,

For week ended 21st July, 1928 —

Kirton, George	1.C.M.E.	North Shields
Martin, Henry G.	1.C.M.E.	,,
Ridley, John	1.C.M.E.	,,
Kay, Matthew M.	2.C.M.E.	,,

For week ended 21st July, 1928—*continued.*

NAME.	GRADE.	PORT OF EXAMINATION.
Maxwell, Thomas C.	2.C.M.E.	North Shields
McNab, Robert W.	1.C.	,,
Purvis, Thomas H.	1.C.	,,
Webster, Douglas G.	1.C.	,,
McKenzie, Kenneth	2.C.	,,
Barclay, Thomas H.	1.C.	Glasgow
Galbraith, Macadam	1.C.	,,
Sheriff, Thomas	1.C.	,,
Manners, Robert	1.C.M.	,,
Gow, Donald F.	2.C.M.	,,
Allan, James	1.C.	Liverpool
Blair, John	1.C.	,,
Dingwell, James L.	1.C.	,,
MacLean, John S.	1.C.	,,
Nuttall, Harry L.	1.C.	,,
Walker, Frank B.	1.C.	,,
Cooper, William J.	2.C.	,,
Slocombe, Edgar G. F.	2.C.	,,
Cook, David	2.C.M.	,,
Crouch, Reginald C.	1.C.	London
Black, Harry	2.C.	,,
Emerson, Albert J. R.	2.C.	,,
Thomas, Peter	1.C.M.E.	,,
Letchford, Harold E.	2.C.	,,
Papworth, Frank H.	2.C.	,,
Poley, Stanley	2.C.	,,
Ward, Wilfrid	2.C.	,,
Wyatt, Albert J.	2.C.	,,
Fraser, Alexander W.	1.C.	Sunderland
Matthews, William H.	1.C.	,,
Barker, Robert A.	2.C.	,,
Pallan, William S.	2.C.	,,
Parkin, Arthur	2.C.	,,
Wilson, Stanley	2.C.	,,
Cruddas, Matthew N. K. ..	2.C.M.	,,
Wright, Percival	1.C.M.E.	,,
Ward, Henry St. J.	2.C.M.E.	,,
Hall, Charles E.	Ex.1.C.	Liverpool
Sharp, Robert N.	Ex.1.C.	North Shields
Wainford, Henry K.	Ex.1.C.	,,

For week ended 28th July, 1928:—

Bennee, Reginald E.	1.C.M.E.	London
Weston, Percy B.	1.C.M.E.	,,
McLeod, John	2.C.M.E.	,,
Thompson, George	Ex.1.C.	Glasgow
Young, William	Ex.1.C.	,,
Toney, James	1.C.	Belfast
Venart, Charles H. S.	2.C.	,,
Cooper, Frederick G.	1.C.	Cardiff
Dyer, Hugh	1.C.	,,
Morgans, Emrys D.	1.C.	,,
Morris, Albert S.	1.C.	,,
Rosser, Harold M.	1.C.	,,
Foote, Ivor W. A. G.	2.C.	,,
Kelly, Eric	2.C.	,,
Johnstone, Thomas T.	1.C.	Glasgow
Brown, Alexander B.	2.C.	,,
Patterson, Athol O. M.	2.C.	,,
Craig, Clement B.	1.C.	Leith
Henderson, John C.	1.C.	,,

For week ended 28th July. 1928—*continued.*

NAME.	GRADE.	PORT OF EXAMINATION.
Hunter, John K.	1.C.	Leith
Beveridge, Peter M.	2.C.	,,
Lawrence, Stewart W.	2.C.	,,
McDonald, George	2.C.	,,
Ritch, James H.	2.C.	,,
Aitken, Alexander W. S. ...	2.C.M.	,,
Gordon, Alfred	1.C.M.E.	,,
Taylor, Frank B.	1.C.	Liverpool
Green William	1.C.	,,
Kingan, William	1.C.	,,
Macbryde, Harold E. K. ...	1.C.	,,
Mayers, Hector	1.C.	,,
Pringle, Gilbert D. F.	1.C.	,,
Robertson, James	1.C.	,,
Bricklebank, Thomas B.... ...	2.C.	,,
Kerr, William F.	2.C.	,,
McBride, Reginald P.	2.C.	,,
Roberts, Tudor L.	2.C.	,,
Hesketh, Richard A.	2.C.M.	,,
Moore, Philip S.	2.C.M.	,,
Gall, George	1.C.	London
Robertson, Andrew D.	1.C.	,,
Cooper, Adrian G. G.	2.C.	,,
Houlding, Harold J.	2.C.	,,
Kingston, Edgar O.	1.C.M.	,,
Cartwright, Alfred	2.C.	North Shields
Hill, Morgan L.	2.C.	,,
Milburn, Edward E.	2.C.	,,
Shaw, Jack	2.C.	,,
Smith, Herbert W.	2.C.	,,
Hunter, William G.	2.C.M.	,,
Wilson, John P.	2.C.M.	,,
Green, Frederic	1.C.	Southampton
Wise, Rodney W. G.	1.C.	,,
Robinson, Basil C.	2.C.	,,
Siggers, Herbert B.	2.C.	,,